California Environmental Protection Agency

Air Resources Board

Health Risk Assessment for the BNSF Railway Sheila Mechanical Railyard

Stationary Source Division

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I. INTRODUCTION

The California Air Resources Board (ARB or Board) conducted a health risk assessment study (study) to evaluate the impacts from airborne particulate matter emissions from diesel-fueled engines associated with activities at the BNSF Railway's (BNSF) Sheila Mechanical Railyard located in Commerce, California. The railyard is approximately 12 miles northeast of San Francisco. The study focused on the railyard property emissions from locomotives, on-road heavy-duty trucks, off-road vehicles, and equipment used to move bulk cargo. Also evaluated were mobile and stationary sources with significant emissions within an off-site boundary of one mile distance from the railyard. This information was used to evaluate the potential health risks associated with diesel particulate matter emissions to those living nearby the railyard.

A. Why ARB is concerned about diesel PM emissions?

In 1998, following an 10-year scientific assessment process, ARB identified particulate matter from diesel exhaust (diesel PM) as a toxic air contaminant based on its potential to cause cancer and other adverse health problems, including respiratory illnesses, and increased risk of heart disease. Subsequent to this action, research has shown that diesel PM contributions to premature deaths[1](ARB, 2002). The diesel PM particles are very small; moreover, approximately 94 percent of the mass of these particles are less than 2.5 microns in diameter ($PM_{2.5}$). Because of their tiny size, diesel PM particles are readily respirable and can penetrate deep into the lung and enter the bloodstream, carrying with them an array of toxins. Exposure to diesel PM is a health hazard, particularly to children whose lungs are still developing and the elderly who may have other serious health problems. Population-based studies in hundreds of cities in the U.S. and around the world demonstrate a strong link between elevated PM levels and premature deaths (Pope et al., 1995, 2002 and 2004; Krewski et al., 2000), increased hospitalizations for respiratory and cardiovascular causes, asthma and other lower respiratory symptoms, acute bronchitis, work loss days, and minor restricted activity days (ARB, 2006a).

Diesel PM emissions typically are the dominant toxic air contaminants in and around a railyard facility. Diesel PM accounts for about 70 percent of the statewide estimated potential ambient air toxic cancer risks based on data from ARB's ambient monitoring network in 2000 (ARB, 2000). These findings were consistent with that of a study conducted in southern California*, Multiple Air Toxics Exposure Study in the South Coast Air Basin*, (SCAQMD, 2000). Based on scientific research findings, the health impacts in this study primarily focus on the risks from the diesel PM emissions.

[1] Premature Death: as defined by U.S. Centers for Disease Control and Prevention's Years of Potential Life Lost, any life ended before age 75 is considered as premature death.

B. Why evaluate diesel PM emissions at the BNSF Sheila Mechanical Railyard?

In 2005, the ARB entered into a statewide railroad pollution reduction agreement (Agreement) (ARB, 2005) with Union Pacific Railroad (UP) and BNSF Railway (BNSF). This Agreement was developed to implement near term measures to reduce diesel PM emissions in and around railyards by approximately 20 percent.

The Agreement requires that health risk assessments be prepared for each of the 17 major or designated railyards in the State. The Agreement requires the railyard health risk assessments to be prepared based on the experience of the UP Roseville Railyard health risk assessment study in 2004 (ARB, 2004a) and the *ARB Health Assessment Guidance for Railyards and Intermodal Facilities* that the ARB staff developed in 2006 (ARB, 2006b). The BNSF Sheila Mechanical Railyard is one of the railyards in the State subject to the Agreement and the health risk assessment requirements.

C. What are Health Risk Assessments (HRAs)?

An exposure assessment is an analysis of amount (i.e., concentration in the air) of a pollutant that a person is exposed to a specific time period. This information is used in a risk assessment to evaluate the potential for an air pollutant to contribute cancer or other health effects. A health risk assessment uses mathematical models to evaluate the health impacts from exposure to certain chemical or toxic air contaminant released from a facility or found in the air. Health risk assessments provide information to estimate potential long term cancer and non-cancer health risks. Health risk assessments do not gather information or health data on specific individuals, but are estimates for the potential health impacts on a population at large.

A health risk assessment consists of three major components: (1) the air pollution emission inventory, (2) the air dispersion modeling, and (3) an assessment of associated risks. The air pollution emission inventory provides an estimate of how air pollutants are generated from different emission sources. The air dispersion modeling incorporates the estimated emission inventory and meteorological data as inputs, then use a computer model to predict the distributions of air toxics in the air. Based on the modeling results, an assessment of the potential health risks from the air toxics to exposed population is performed. The results are expressed in a number of ways as summarized below.

- For potential cancer health effects, the risk is usually expressed as the number of chances in a population of a million people. The number may be stated as “10 in a million” or “10 chances per million”. The methodology used to estimate the potential cancer risks is consistent with the Tier-1 analysis of *Air Toxics Hot Spots Program Risk Assessment Guidelines* (OEHHA, 2003). A Tier-1 analysis assumes that an individual is exposed to an annual average concentration of a given pollutant continuously for 70 years. The length of time that an individual is exposed to a given air concentration is proportional to the risk. Children, however, are impacted more during the childhood period. Exposure durations of 30 years or 9 years may also be evaluated as supplemental information to present the range of cancer risk based on residency period.

- For non-cancer health effects, a reference exposure level is used if there will be certain identified adverse health impacts, such as lung irritation, liver damage, or birth defects. These adverse health effects may happen after chronic (long-term) or acute (short-term) exposure. To calculate a non-cancer health risk, the reference exposure level (REL)[2] is compared to the concentration that a person is exposed to and a hazard index (HI) is calculated. The higher the hazard index is above 1.0, the greater the potential for possible adverse health impacts. If the hazard index is less than 1.0, then it is an indicator that adverse impacts are less likely to occur.

- For premature deaths linked to diesel PM emissions in the South Coast Air Basin, ARB staff estimated about 1,300 premature deaths per year due to diesel exhaust exposure in 2000 (ARB Research Division, and Lloyd and Cackette, 2001). The total diesel PM emission from all sources in the South Coast Air Basin is about 7,750 tons per year in 2005 (ARB, 2006c). The total diesel PM emissions from the BNSF Sheila Mechanical Railyard, on the other hand, are an estimated about 2.7 tons for the year 2005, about 0.03% of total air basin diesel PM emissions. In comparison with another major source of diesel PM emissions in the South Coast Air Basin, the combined diesel PM emissions from the Port of Los Angeles/Port of Long Beach were estimated to be about 1,760 tons per year, contributing an estimated 29 premature deaths per year (ARB, 2006d).

The potential cancer risk from known carcinogens estimated from the health risk assessment is expressed as the incremental number of potential cancers that could develop per million people assuming the population is exposed to the carcinogen at a defined concentration over a presumed 70-year lifetime. The ratio of potential number of cancers per million people can also be interpreted as the incremental likelihood of an individual exposed to the carcinogen developing cancer from continuous exposure over

[2] The Reference Exposure Level (REL) for diesel PM is essentially the U.S. EPA Reference Concentration first developed in the early 1990s based on histological changes in the lungs of rats. Since the identification of diesel PM as a Toxic Air Contaminant (TAC), California has evaluated the latest literature on particulate matter health effects to set the Ambient Air Quality Standard. Diesel PM is a component of particulate matter. Health effects from particulate matter in humans include illness and death from cardiovascular and respiratory disease, and exacerbation of asthma and other respiratory illnesses. Additionally, a body of literature has been published, largely after the identification of diesel PM as a TAC and adoption of the REL, which shows that diesel PM can enhance allergic responses in humans and animals. Thus, it should be noted that the REL does not reflect adverse impacts of particulate matter on cardiovascular and respiratory disease and deaths, exacerbation of asthma, and enhancement of allergic response.

a lifetime. For example, if the cancer risk were estimated to be 100 chances per million, then the probability of an individual developing cancer would not be expected to exceed 100 chances in a million. If a population (e.g., one million people) were exposed to the same potential cancer risk (e.g., 100 chances per million), then statistics would predict that no more than 100 of those million people exposed would be likely to develop cancer from a lifetime of exposure (i.e., 70 years) due to diesel PM emissions from a facility.

The health risk assessment is a complex process that is based on current knowledge and a number of assumptions. However, there is a certain extend of uncertainty associated with the process of risk assessment. The uncertainty arises from lack of data in many areas necessitating the use of assumptions. The assumptions used in the assessment are often designed to be conservative on the side of health protection in order to avoid underestimation of risk to the public. As indicated by the OEHHA Guidelines, the Tier-1 evaluation is useful in comparing risks among a number of facilities and similar sources. Thus, the risk estimates should not be interpreted as a literal prediction of disease incidence in the affected communities but more as a tool for comparison of the relative risk between one facility and another. Therefore, risk assessment results are best used to comparing potential risks to target levels to determine the level of mitigation needed. They are also an effective tool for determining the impact a particular control strategy will have on reducing risks.

OEHHA is in the process of updating the current health risk assessment guidelines, and ARB and the two railroads (UP and BNSF) agreed to evaluate the non-cancer health impacts using an interim methodology. This was used in the Diesel Particulate Matter Exposure Assessment Study for the Ports of Los Angeles and Long Beach (ARB, 2006d) to evaluate PM mortality. This will serve as a short-term and interim effort until OEHHA can complete its update of the Guidelines.

As soon as the HRAs are final, both the ARB and Railroads in cooperation with the SCAQMD staff, local citizens and others will begin a series of meetings to identify and implement measures to reduce emissions from railyard sources. Existing effects are detailed in Chapter III-C.

D. Who prepared the BNSF Sheila Mechanical Railyard HRA?

Under the Agreement, ARB worked with affected local air quality management districts, counties, cities, communities, and two railroads to develop two guideline documents for performing the health risk assessments. The two documents, entitled *ARB Health Risk Assessment Guidance for Railyard and Intermodal Facilities* (ARB, 2006b) and *ARB Railyard Emissions Inventory Methodology* (ARB, 2006e) provide guidelines for the identification, modeling, and evaluation of the toxic air contaminants from designated railyards throughout California. Using the guidelines, the railroads developed the emission inventories based on the year 2005 activities and performed the air dispersion modeling for all operations that occur within each of the designated railyards.

ARB staff is responsible for reviewing and approving the railroads' submittals, identifying significant sources of emissions near the railyards and modeling the impacts of those sources, and preparing the railyard health risk assessments. ARB staff is also responsible for releasing the draft HRAs to the public for comment and presenting them at community meetings. After reviewing public comments on the draft HRAs, ARB staff made revisions as necessary and appropriate, and is now presenting the HRAs in final form. Ultimately, the information derived from the railyards HRAs are to be used to help identify the most effective mitigation measures that could be implemented to further reduce railyard emissions and public health risks.

E. How is this report structured?

The next chapter provides a summary of the BNSF Sheila Mechanical Railyard operations, emissions, air dispersion modeling, and health risk assessment results. Following the summary, the next chapters present the details of the analyses of emission inventory, air dispersion modeling, and health risk assessment. The appendices present the technical supporting documents of the study.

II. SUMMARY

The study estimated the 2005 base-year diesel PM emissions generated from the BNSF Sheila Mechanical Railyard and off-site emission sources. The operation activities and emissions within the BNSF Sheila Mechanical Railyard, the emissions within a two-mile off-site boundary from the railyard, and the health risk assessment are summarized as below.

A. General description of the BNSF Sheila Mechanical Railyard and the Surrounding Areas

The BNSF Sheila Mechanical Railyard is located in Commerce, California and is approximately 6 miles east of Los Angeles. As shown in Figure II-1, the facility is located in commercial and manufacturing area with several residential areas located within one mile. The facility is bordered by Washington Boulevard to the north, Interstate-5 (I-5) to the east, the adjacent locomotive main line of the railyard to the south, and commercial properties to the west. The facility is also located within 3 miles of three other major roadways, including (1) I-710 to the west, (2) I-605 to the east, and (3) highway CA-60 to the north. There are three other railyards in the area close to the BNSF Sheila Mechanical Railyard: (1) the UP Commerce, (2) the BNSF Hobart, and (3) the BNSF Commerce Eastern Railyards (see Figure II-1).

B. What are the primary facility operations at the BNSF Sheila Mechanical Railyard?

The BNSF Sheila Mechanical Railyard is a locomotive mechanical shop facility, and mainly supports the operations at the BNSF Hobart Railyard nearby. Operations at the railyard include locomotive fueling, locomotive maintenance, locomotive line haul, passenger locomotives, track maintenance, portable power generators, on-road fleet vehicles, and other stationary sources. There were 14,577 locomotives serviced at the BNSF Sheila Mechanical Railyard in 2005.

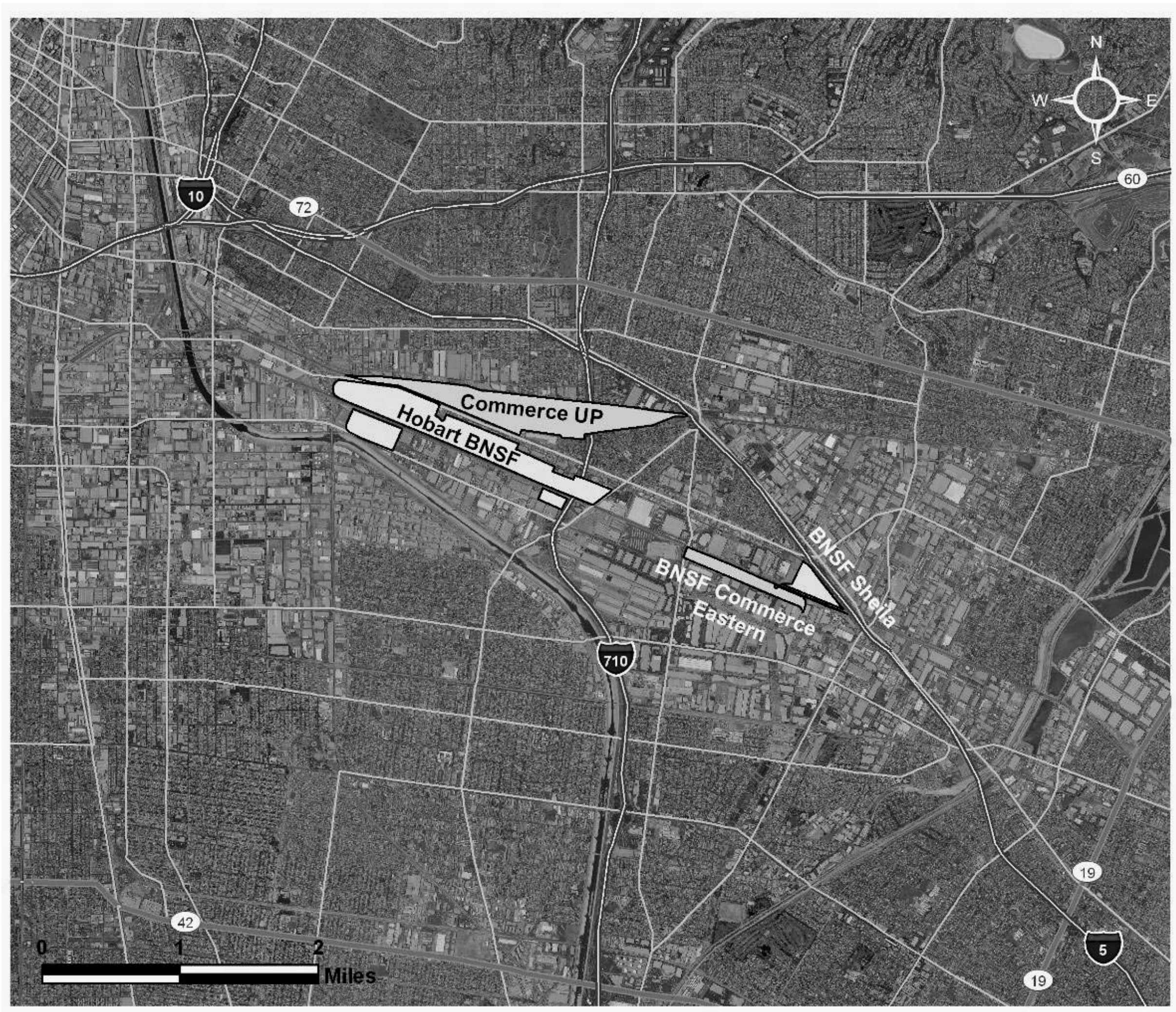


Figure II-1 The location of BNSF Sheila Mechanical Railyard and the surrounding areas.

C. What are the diesel PM emissions at and near the BNSF Sheila Mechanical Railyard?

In 2005, total diesel PM emissions combined from the BNSF Sheila Mechanical Railyard and within a two-mile joint off-site boundary of four Commerce railyards (see Figure II-2) were estimated at about 116 tons per year. Separated from the four railyard emissions, the diesel PM emissions from off-site sources and activities, including both mobile and stationary sources, were estimated at about 113 tons per year, or about 98% of total diesel PM emissions (i.e., on-site and off-site together). The diesel PM emissions at the BNSF Sheila Mechanical Railyard are estimated at about 2.7 tons per year or about 2% of total diesel PM emissions. Table II-1 summarizes three major diesel PM source categories within all designated railyards that the HRAs are scheduled to be completed in 2007.

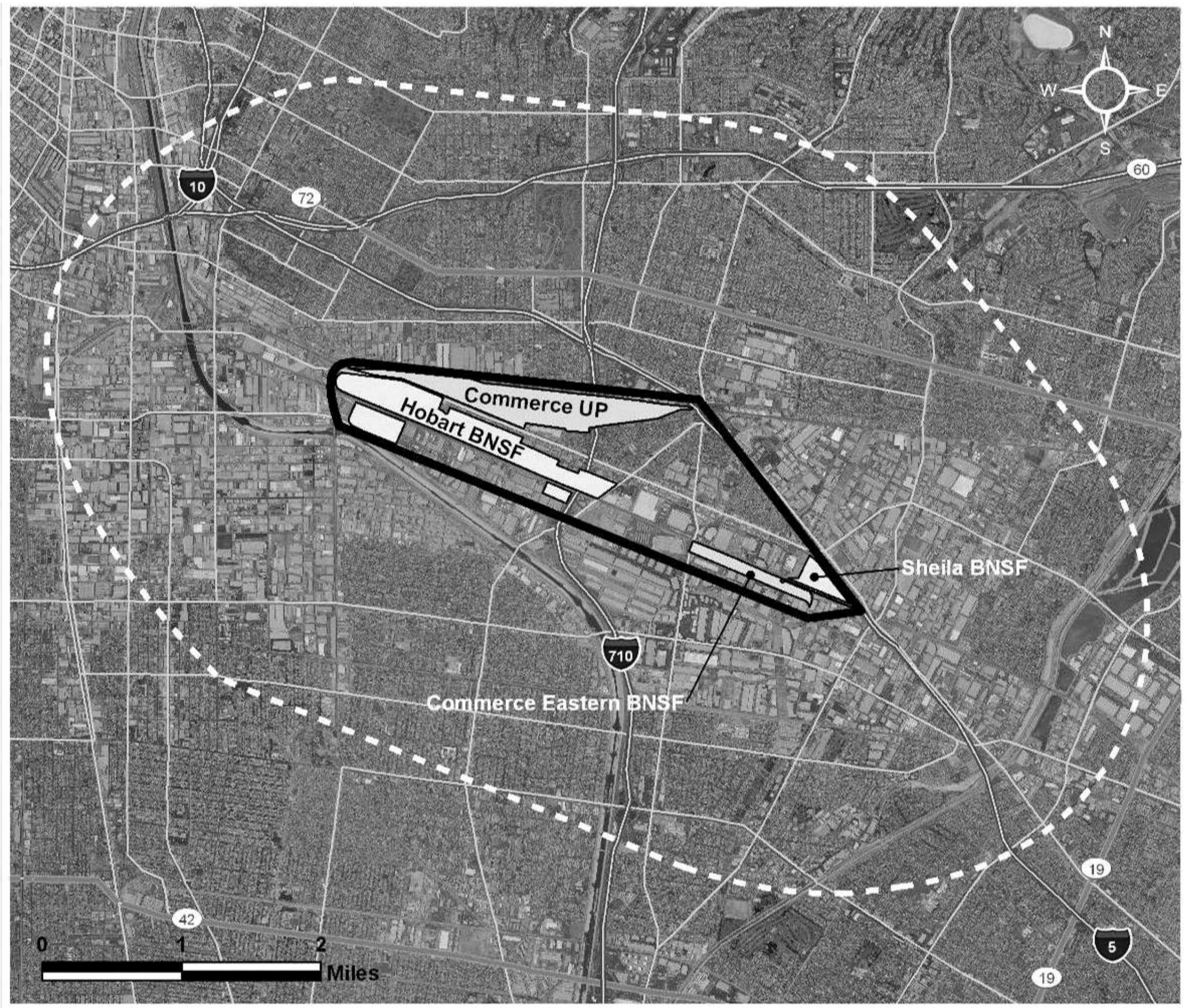


Figure II-2 Combined railyard boundary (solid line) and two-mile joint off-site boundary (dashed line) of the four Commerce Railyards, (1) the UP Commerce, (2) the BNSF Hobart, (3) the BNSF Sheila Mechanical, and (4) the BNSF Commerce Eastern Railyards.

Table II-1 Comparisons of diesel PM emissions from three major source categories within designated railyards..

Designated Railyards	Locomotives	Cargo Handling Equipment	On-road Trucks	Off-road and Stationary Sources	Total†
UP Roseville*	25.1**	N/A‡	N/A‡	N/A‡	**25.1**
BNSF Hobart	5.9	4.2§	10.1	3.7	**23.9**
UP Commerce	4.9	4.8§	2.0	0.4	**12.1**
UP LATC	3.2	2.7§	1.0	0.5	**7.3**
UP Stockton	6.5	N/A‡	0.2	0.2	**6.9**
UP Mira Loma	4.4	N/A‡	0.2	0.2	**4.8**
BNSF Richmond	3.3	0.3	0.5	0.6	**4.7**
BNSF Stockton	3.6	N/A‡	N/A‡	0.02	**3.4**
BNSF Commerce Eastern	0.6	0.4	1.1	1.0	**3.1**
BNSF Sheila	2.2	N/A‡	N/A‡	0.4	**2.7**
BNSF Watson	1.9	N/A‡	< 0.01	0.04	**1.9**

* The UP Roseville Health Risk Assessment (ARB, 2004) was based on 1999-2000 emission estimate, only locomotive diesel PM emissions were reported in that study.
** The actual emissions were estimated at a range of 22.1 to 25.1 tons per year.
‡ Not applicable
† Number s may not add precisely due to rounding.
§ An error of cargo handling equipment emissions was found after the modeling was completed. The applicable change in emissions was believed to be de minimis; consequently, the modeling was not re-performed.

1. Railyard Emissions

The BNSF Sheila Mechanical Railyard emission sources include, but are not limited to, locomotives, on-road trucks, off-road diesel-fueled equipment, and fuel storage tanks. The facility operates 24 hours per day, 365 days per year. The emissions were calculated on a source-specific and facility-wide basis for the 2005 baseline year. There were 14,577 recorded locomotives for maintenance and services at the facility in 2005. The future growth in emissions at the BNSF Hobart facility is not incorporated in the HRA emission inventory, but will be included as part of the mitigation emission reduction efforts. The methodology used to calculate the diesel PM and other TAC emissions is based on the *ARB Railyard Emission Inventory Methodology* (ARB, 2006e). The locomotive emission factors used in the study is presented in Appendix D.

Within the BNSF Sheila Mechanical Railyard facility, 83% of total diesel PM emissions were estimated to be from locomotive operations, at about 2.2 tons per year. The locomotive diesel PM emissions are primarily due to maintenance and services, comprising about 2.0 tons per year. The railway operations, primarily switching locomotives and moving railcars within the facility, contribute 0.2 tons per year. The activities of Commuter locomotives account for 0.03 tons of diesel PM emissions per year. The remaining 16% or 0.43 tons of the railyard diesel PM emissions per year are generated by the other operations from diesel-fueled vehicles and equipment, off-road engines, and railyard stationary equipment and facilities. The diesel PM emissions at the railyard are categorized in Table II-2.

Diesel PM is not the only toxic air contaminant (TAC) emitted in the BNSF Sheila Mechanical Railyard. Other toxic air contaminants are emitted from gasoline-fueled vehicles and engines, and fuel storage tanks. The total amount of these toxic air contaminant emissions is about 0.01 tons or 30 pounds per year, which is significantly less than the diesel PM emissions in the railyard. Most of these toxic air contaminants are not identified as carcinogen according to the OEHHA Guidelines (OEHHA, 2003). Using the cancer potency weighting factor, these non-diesel PM toxic air contaminants have substantially lower levels of potential cancer risks, about a factor of 330 less, as compared to the diesel PM, a predominant emission at the BNSF Sheila Mechanical Railyard. Hence, only diesel PM emissions are presented in the on-site emission analysis.

2. Surrounding Sources

ARB staff evaluated significant mobile and stationary sources of diesel PM emissions surrounding the BNSF Sheila Mechanical Railyard. The Health Risk Assessment study for the UP Roseville Railyard (ARB, 2004a) indicated that cancer risks associated with on-site diesel PM emissions are substantially reduced beyond a one-mile distance from the railyard. There are four railyards located in the city of Commerce: (1) the UP Commerce, (2) the BNSF Hobart, (3) the BNSF Commerce/Eastern, and (4) the BNSF Sheila Mechanical Railyards. In order to cover the zone of significant health impacts associated with emissions from all of the four railyards in Commerce, ARB staff chose to analyze the off-site diesel PM emission sources within an off-site boundary with a two-mile distance from the combined railyard perimeter of the four Commerce railyards, as shown by the dashed outer line in Figure II-2.

For the off-site mobile sources, the analysis focused on heavy duty diesel trucks, since they are the primary source of diesel PM from the on-road vehicle fleet. ARB staff estimated mobile emissions based on roadway specific vehicle activity data and allocated them to individual roadway links. All roadway links within the two-mile joint off-site boundary are included in the analysis. The estimates do not include the diesel PM emissions generated from other modes such as extended idling, starts, and off-road diesel-fuel equipment outside the railyard. Individual sources such as local truck distribution centers and warehouses were not evaluated due to insufficient source-specific activity data; however, the trucking flow related to these local facilities was integrated into overall traffic volume on a county basis. Because the off-site mobile sources have only focused on the on-road truck diesel emissions, the exclusion of extended idling and off-road mobile sources may result in an underestimation.

Emissions from off-site stationary source facilities are identified using the California Emission Inventory Development and Reporting System (CEIDARS) database, which contains information reported by the local air districts for stationary sources within their jurisdiction. The facilities recorded in the CEIDARS database, whose locations fell within the two-mile joint off-site boundaries of the four Commerce railyards, were integrated. Diesel PM emissions are estimated from stationary internal combustion (IC) engines burning diesel fuel, and operating at stationary sources reported in CEIDARS database.

Within the two-mile joint off-site boundary, the diesel PM emissions are predominantly generated by mobile sources that account for approximately 113 tons per year, as shown in Table II-2. A large portion of the off-site diesel PM emissions are from diesel-fueled heavy duty trucks traveling on I-5, I-710, CA-60, I-10, and major local streets. There are some stationary diesel PM sources that are estimated less than 400 pounds of emissions per year. The three major stationary sources, (1) Los Angeles City Department of General Services, (2) City of Vernon Light & Power Department, and (3) Los Angeles County Sheriff's Department, contribute about 300 pounds of diesel PM emissions per year. The off-site diesel PM emission inventory does not include emissions from the other three railyards nearby, i.e., the UP Commerce, the BNSF Hobart, and the BNSF Commerce Eastern. The diesel PM emissions from the BNSF Sheila Mechanical Railyard and from the off-site sources within the two-mile joint off-site boundary are summarized in Table II-2.

ARB staff also evaluated other toxic air contaminants emissions around the BNSF Sheila Mechanical Railyard. There are 2,620 stationary toxic air contaminant sources identified between the four-railyard combined perimeter and the two-mile joint off-site boundary. The total emissions of toxic air contaminants, other than diesel PM emitted from these stationary sources, were estimated at about 210 tons per year. Over 100 toxic air contaminants are identified among these emissions, in which ammonia, toluene and methyl chloroform are the three major contributors with emissions estimated at 57, 25, and 24 tons per year, respectively. Not all of these toxic air contaminants are identified as carcinogens. According to ARB's *Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles* (ARB, 2000), diesel PM, 1,3-butadiene, benzene, carbon tetrachloride, and formaldehyde are defined as the top 5 potential cancer risk contributors, based on ambient concentrations. These TACs account for 95% of the State's estimated potential cancer risk levels. This study also concluded that diesel PM contributes over 70% percent of the statewide estimated potential cancer risk levels, which are significantly higher than other TACs (ARB, 2000).

Among the off-site TACs emissions, the top 5 cancer risk contributors other than diesel PM are estimated at about 1.6 tons per year.

Table II-2 BNSF Sheila Mechanical Railyard and surrounding area diesel PM emissions

Diesel PM Emission Sources	Sheila Mechanical Railyard		Off-site Emissions‡	
	Tons per Year*	Percentage*	Tons per Year	Percentage
Locomotives	2.2	83 %	-	-
Off-road Vehicles and Equipment	0.4	16 %	-	-
On-road Vehicle Fleet	< 0.01	< 0.1 %	-	-
Other Stationary Sources	< 0.01	< 0.1 %	-	-
Off-site Mobile Sources	-	-	113.2	100 %
Off-site Stationary Sources	-	-	0.2	< 0.2 %
Total	2.7	100 %	113.4	100 %

* Numbers may not add precisely due to rounding.

‡ Emissions within the two-mile joint off-site boundary, and emissions from other three Commerce railyards, i.e., UP Commerce, BNSF Hobart and BNSF Commerce/Eastern, not included.

The Office of Environmental Health Hazard Assessment (OEHHA) has estimated an inhalation cancer potency factor (CPF) for individual chemicals and some chemical mixtures such as whole diesel exhaust. Diesel PM contains many individual cancer causing chemicals. The individual cancer causing chemicals from diesel exhaust are not separately evaluated so as to avoid double counting. The four compounds listed here are given a weighing factor by comparing each compound's CPF to the diesel PM CPF. This factor is multiplied by the estimated emissions for that compound, which gives the cancer potency weighted toxic emission as shown in Table II-3. As seen in Table II-3, the potency weighted toxic emissions for these TACs are

Cancer potency factors (CPF) are expressed as the 95% upper confidence limit of excess cancer cases occurring in an exposed population assuming continuous lifetime exposure to a substance at a dose of one milligram per kilogram of body weight, and are expressed in units of $(mg/kg\text{-}day)^{-1}$.

about 0.07 tons per year, which is substantially less than the diesel PM emissions.

In addition, ARB staff evaluated the potential cancer risk levels contributed by the use of gasoline in the South Coast Air Basin. Table II-4 shows the emissions of four primary carcinogen compounds from gasoline exhausts in the South Coast Air Basin in 2005 (ARB, 2006c). As indicated in Table II-4, the cancer potency weighted emissions of these four toxic air contaminants from all types of gasoline sources are estimated at about 816 tons per year, or about 11% of diesel PM emissions in the South Coast Air Basin. If only gasoline-powered vehicles are considered, the potency weighted emissions of these four TACs are estimated at about 438 tons per year, or equivalent to about 6% of diesel PM emissions in the Basin. Because the dominance of diesel PM emissions on the area health risk, the gasoline-powered vehicular sources are not included in the analysis.

Table II-3 Cancer potency weighted TAC emissions from significant emission sources within the two-mile joint off-site boundary.

Toxic Air Contaminant	Cancer Potency Factor	Weighting Factor	Actual Emission (tons/year)	Potency Weighted Toxic Emission (tons/year)
Diesel PM	1.1	1	113.4	113.4
1,3-Butadiene	0.6	0.55	< 0.01	< 0.01
Benzene	0.1	0.09	0.44	0.04
Carbon Tetrachloride[3]	0.15	0.14	< 0.01	< 0.01
Formaldehyde	0.021	0.021	1.16	0.02
Total (other than diesel PM)			1.6	0.07

[3] Very small amount of carbon tetrachloride are emitted today. Ambient concentrations are highly influenced by past emissions due to the long atmospheric life time of this compound.

Table II-4 Emissions of major toxic air contaminants from gasoline exhausts in the South Coast Air Basin

Toxic Air Contaminant	TACs Emissions (tons/year)			
	From All Sources	**Potency Weighted****	**From Gasoline Vehicles**	**Potency Weighted****
Diesel PM	7,446	**7,446**	-	-
1,3-Butadiene	695	**382**	420	**231**
Benzene	3,606	**325**	2,026	**182**
Formaldehyde	4,623	**92**	1,069	**21**
Acetaldehyde	1,743	**16**	314	**3**
Total (other than diesel PM)	10,668	**816**	3,829	**438**

* Based on cancer potency weighting factors.

D. What are the potential cancer risks from the BNSF Sheila Mechanical Railyard?

As discussed previously, the ARB has developed *Health Risk Assessment Guidance for Railyard and Intermodal Facilities* (ARB, 2006b) to ensure that the methodologies used in railyard HRAs meet the requirements for the ARB/Railroad Statewide Agreement. The railyard HRAs follow *The Air Toxics Hot Spots Program Risk Assessment Guidelines* published by the Office of Environmental Health Hazard Assessment (OEHHA, 2003), and is consistent with the UP Roseville Railyard Study (ARB, 2004a).

The U.S. EPA recently approved a new state-of-science air dispersion model, AERMOD (American Meteorological Society/EPA Regulatory Model Improvement Committee MODEL). This model is used in the ARB railyard health risk assessments. One of the critical inputs required for the AERMOD is the meteorology, such as wind direction and wind speed. These parameters determine where and how the pollutants will be transported. Based on the AERMOD meteorological data selection criteria, four meteorological stations around the BNSF Sheila Mechanical Railyard were evaluated and the data collected at the Lynwood station, operated by South Coast Air Quality Management District, was selected for the modeling.

The potential cancer risks from the diesel PM emissions at the BNSF Sheila Mechanical Railyard are estimated by risk isopleths presented in Figure II-3. The estimated potential cancer risk is about 250 chances per million near the railyard property boundaries. Beyond the railyard boundaries, the estimated potential cancer risks decrease rapidly to about 100 chances per million, and the risks further decrease to 25 in a million within about a mile from the railyard then to 10 in a million within an another mile distance in downwind area.

An **isopleth** is a line drawn on a map through all points of equal value of some measurable quantity; in this case, cancer risk.

The OEHHA Guidelines require that for health risk assessments, the cancer risk for the maximum exposure at the point of maximum impact should be reported. The point of maximum impact (PMI) is a location or the receptor point with the highest cancer risk level outside of the railyard boundary, with or without residential exposure, is predicted to be located at the north side of the railyard fence line. The PMI location for the BNSF Sheila Mechanical Railyard was identified at the northeast of the facility, between the railyard fence line and the Interstate I-5, shown in Figure II-3. This is downwind of high emission density area for the prevailing southwesterly wind, where about 65 percent of facility-wide diesel PM emissions were generated (see the emission allocation in Appendix F). Given the model implemented data, the estimated cancer risk at the PMI is about 490 chances per million for the 70-year exposure. The land use in the vicinity of the PMI is primarily zoned for transportation and industrial use. However, there can be residents potentially to live within this zoned area. In the residential zoned area, the potential cancer risk of maximally exposed individual resident (MEIR) or maximum individual cancer risk (MICR) is estimated at about 40 chances in a million. As indicated by Roseville Railyard Study (ARB, 2004a), the location of the point of maximum impact may vary depending upon the settings of the model inputs and parameters, such as meteorological data set or emission allocations in the railyard. Therefore, given the estimated emissions, modeling settings, and the assumptions applied to the risk assessment, there are great uncertainties associated with the estimation of PMI and MICR. These indications should not be interpreted as a literal prediction of disease incidence but more as a tool for comparison. In addition, the estimated point of maximum impact and maximum individual cancer risk may not be replicated by air monitoring.

ARB staff also conducted a comparison of cancer risks estimated at the PMI versus MICR, and the differences of facility-wide diesel PM emissions between the UP and BNSF railyards. The ratios of cancer risks at the PMI or MICR to the diesel PM emissions do not suggest that one railroad's facilities have statistically higher cancer risks than the other railroad's or vice versa. Rather, the differences are primarily due to emission spatial distributions from individual operations among railyards.

The large populated areas near the BNSF Sheila Mechanical Railyard are located east and northeast of the railyard, about four-mile distance from the railyard property. The nearest residential area is located northwest of the railyard, about one mile from the railyard boundary, where the highest residential exposure is estimated. The zone of impact between the estimated risks of 10 and 50 in a million levels encompasses approximately 3,200 acres where about 30,300 residents live according to the 2000 U.S. Census Bureau's data. Table II-5 presents the exposed population and area coverage size for various impacted zones of potential cancer risks shown in Figure II-3. To conservatively communicate the risks, ARB staff presents the estimated cancer risk isopleths all based on 70-year (lifetime) residential exposure duration, even for those impacted industrial areas where no resident inhabits.

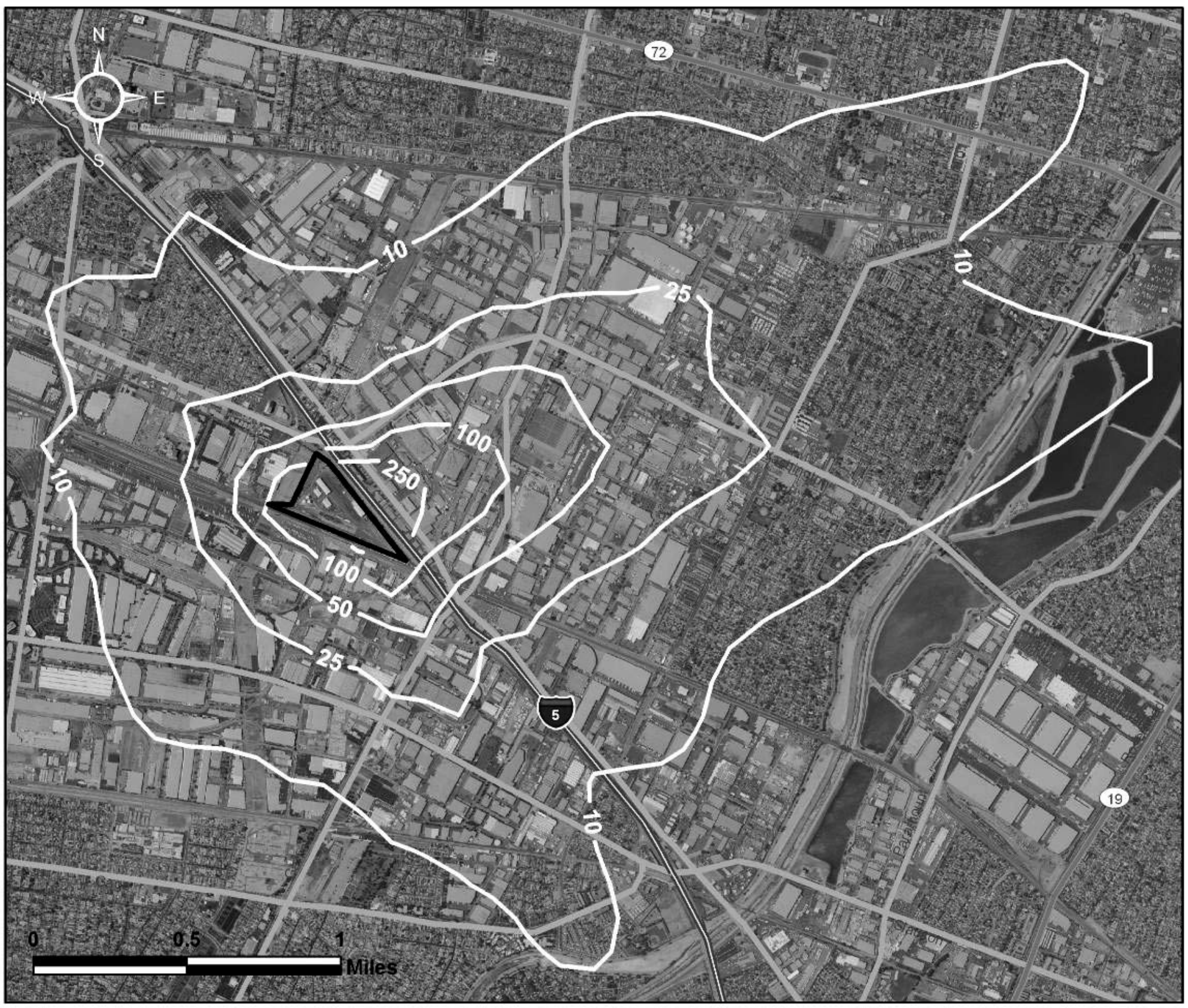


Figure II-3 Estimated potential cancer risks (chances per million) associated with the diesel PM emissions from the BNSF Sheila Mechanical Railyard (based on 80th percentile breathing rate and 70-year exposure) .

Table II-5 Area coverage and exposed population of impacted zones for estimated potential cancer risk levels based on 80th percentile breathing rate and 70-year exposure.

Impacted Zone (chances per million)	Impacted Area (acres)	Estimated Population Exposed
25 - 50	600	2,300
10 - 25	2,600*	28,000

The OEHHA Guidelines recommend a 70-year lifetime exposure duration to evaluate the potential cancer risks for residents. Shorter exposure durations of 30 years and 9 years may also be evaluated as supplement information. The exposure durations – 70 years, 30 years, and 9 years – all assume exposure for 24 hours a day, and 7 days a week. It is important to note that children, for physiological as well as behavioral reasons, have higher rates of exposure than adults on a per unit body weight basis (OEHHA, 2003). To evaluate the potential cancer risks for off-site workers, the OEHHA Guidelines recommend that a 40-year exposure duration be used, assuming workers have a different breathing rate (149 L kg^{-1} day^{-1}) and exposure for an 8-hour workday, five days a week, 245 days a year.

Table II-6 shows the equivalent risk levels of 70- and 30-year exposure durations for exposed residents; and 40- and 9-year exposure durations for off-site workers and school-aged children, respectively. As Table II-6 shows, the isopleth line of 10 in a million in Figure II-3 would become 4 in a million for exposed population with a shorter residency of 30 years, 2.5 in a million for exposed children, and 2 in a million for off-site workers.

Table II-6 Equivalent potential cancer risk levels for 70, 40 and 9-year exposure durations (based on Tier-1 methodology).

Exposure Duration (years)	Equivalent Risk Level (Chance in a million)				
70	10	25	50	100	250
30	4	11	21	43	107
9*	2.5	6.3	12.5	25	63
40‡	2	5	10	20	50

* Exposure duration for school-aged children during the first 9-year childhood.
‡ Exposure duration for off-site workers.

It is necessary to note that these risk levels represent the predicted risks (associated with the BNSF Sheila Mechanical Railyard diesel PM emissions) above the existing background risk levels. For the broader South Coast Air Basin, the estimated regional background risk level is estimated to be about 1,000 in a million contributed by all toxic air contaminants in 2000 (ARB, 2006c). Figure II-4 illustrates a comparison of the estimated average potential cancer risks to the regional background cancer risk level. For example, in the cancer risk ranges between 25 and 50 chances per million due to the diesel PM emissions from the BNSF Sheila Mechanical Railyard, the estimated average potential cancer risk above the regional background is about 35 chances per million. Therefore, residents living in the area with a cancer risk ranging from 25 to 50 chances per million would have a potential cancer risk at about 1,035 chances per million population.

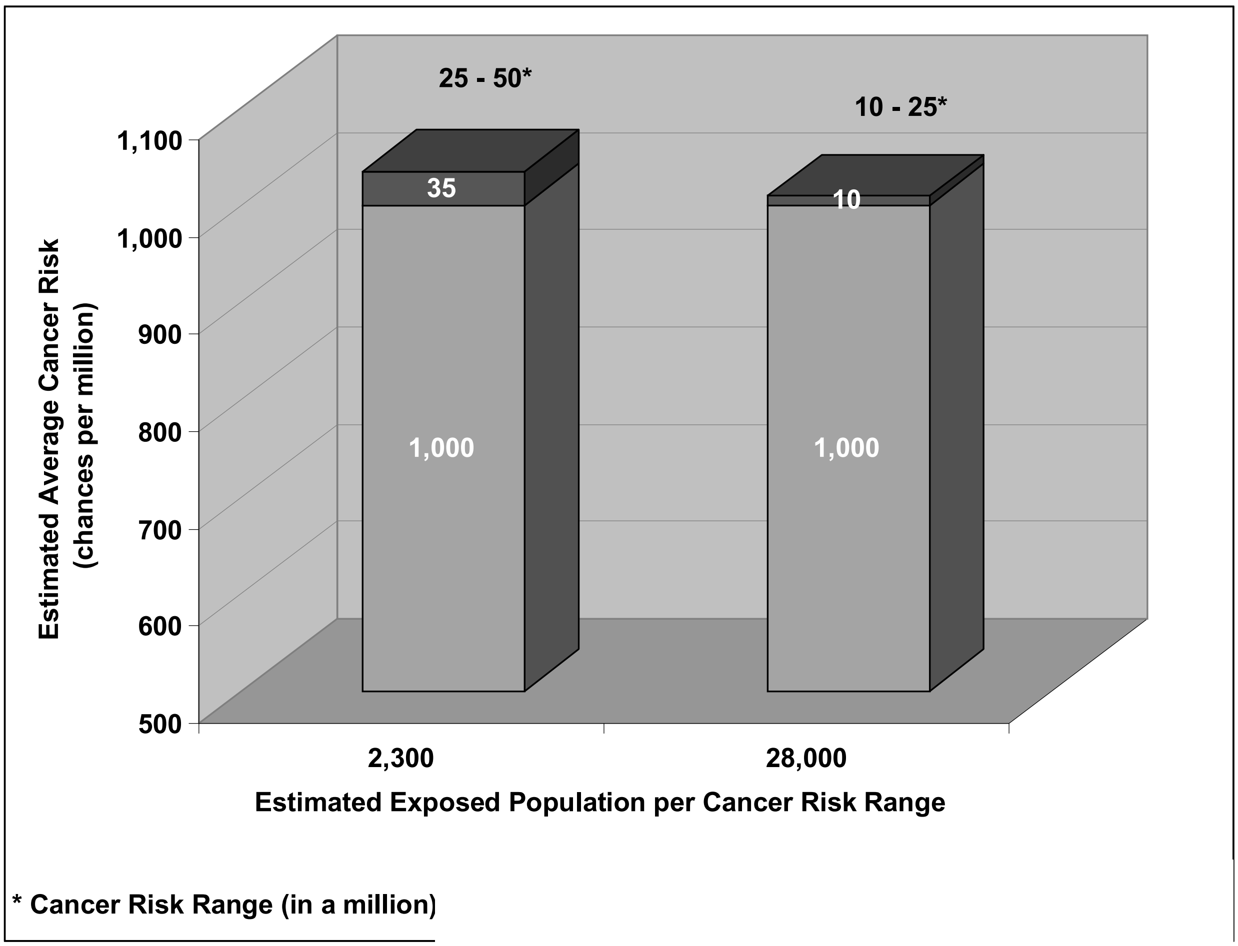


Figure II-4 Comparison of estimated potential cancer risks due to the diesel PM emissions from the BNSF Sheila Mechanical Railyard and the regional background cancer risk levels.

E. What are the estimated non-cancer chronic risks near the BNSF Sheila Mechanical Railyard?

The non-cancer chronic health impacts are evaluated as hazard indices. The associate hazard indices due to the diesel PM emissions from the BNSF Sheila Mechanical Railyard are estimated ranging from 0.02 to 0.2 at the surrounding areas. As compared to 1.0, the estimated hazard indices are much lower, and may suggest that the potential non-cancer chronic health risks are less likely to occur.

Due to the uncertainties in the toxicological and epidemiological studies, diesel PM as a whole was not assigned a short-term acute REL. It is only the specific compounds of diesel exhaust (e.g., acrolein) that independently have potential acute effects (such as irritation of the eyes and respiratory tract), and an assigned acute REL. However, acrolein is a chemically reactive and unstable compound, and easily reacts with a variety of chemical compounds in the atmosphere. Compared to the other compounds in diesel exhaust, the concentration of acrolein has a much lower chance of reaching a distant off-site receptor. More importantly, given the multitude of activities ongoing at facilities as complex as railyards, there is a much higher level of uncertainty associated with hourly-specific emission data and hourly model-estimated peak concentrations for short-term exposure. It is essential to assess the acute risk according to the OEHHA guidelines. Therefore, non-cancer acute risk is not addressed quantitatively in this study. From a risk management perspective, ARB staff believes it is reasonable to focus on diesel PM cancer risk because it is the predominant risk driver and the most effective parameter to evaluate risk reduction actions. Further, actions to reduce diesel PM emissions will also effectively reduce the associated non-cancer risks.

F. What are the estimated health risks from off-site emissions?

ARB staff evaluated the health impacts from off-site pollution sources near the Commerce railyard facilities using the U.S. EPA-approved AERMOD dispersion model. The mobile and stationary diesel PM emission sources located within the two-mile joint off-site boundary were included in the off-site emission inventory but separated from all on-site emissions from the Sheila Mechanical and other three railyards nearby. Off-site diesel PM emissions used in the modeling simulations consisted of about 113.2 tons per year from roadways and 0.2 tons per year from stationary facilities in 2005. The estimated potential cancer risks associated with off-site diesel PM emissions are illustrated in Figure II-5. The zone of impacts of estimated cancer risks associated with off-site diesel PM emissions is much larger as compared to that associated with the BNSF Sheila Mechanical Railyard diesel PM emissions.

Based on the 2000 U.S. Census Bureau’s data, the zone of impact of the estimated potential cancer risks above 100 cases in a million levels associated with off-site diesel PM emissions encompasses approximately 28,300 acres where about 430,000 residents live. Table II-7 presents the exposed population and area coverage for various impacted zones of potential cancer risks associated with off-site diesel PM emissions. The impacted area with an estimated potential cancer risk level exceeding 10 chances in a million encompasses about 198,000 acres and about 1.9 million people inhabit according to the 2000 Census data.

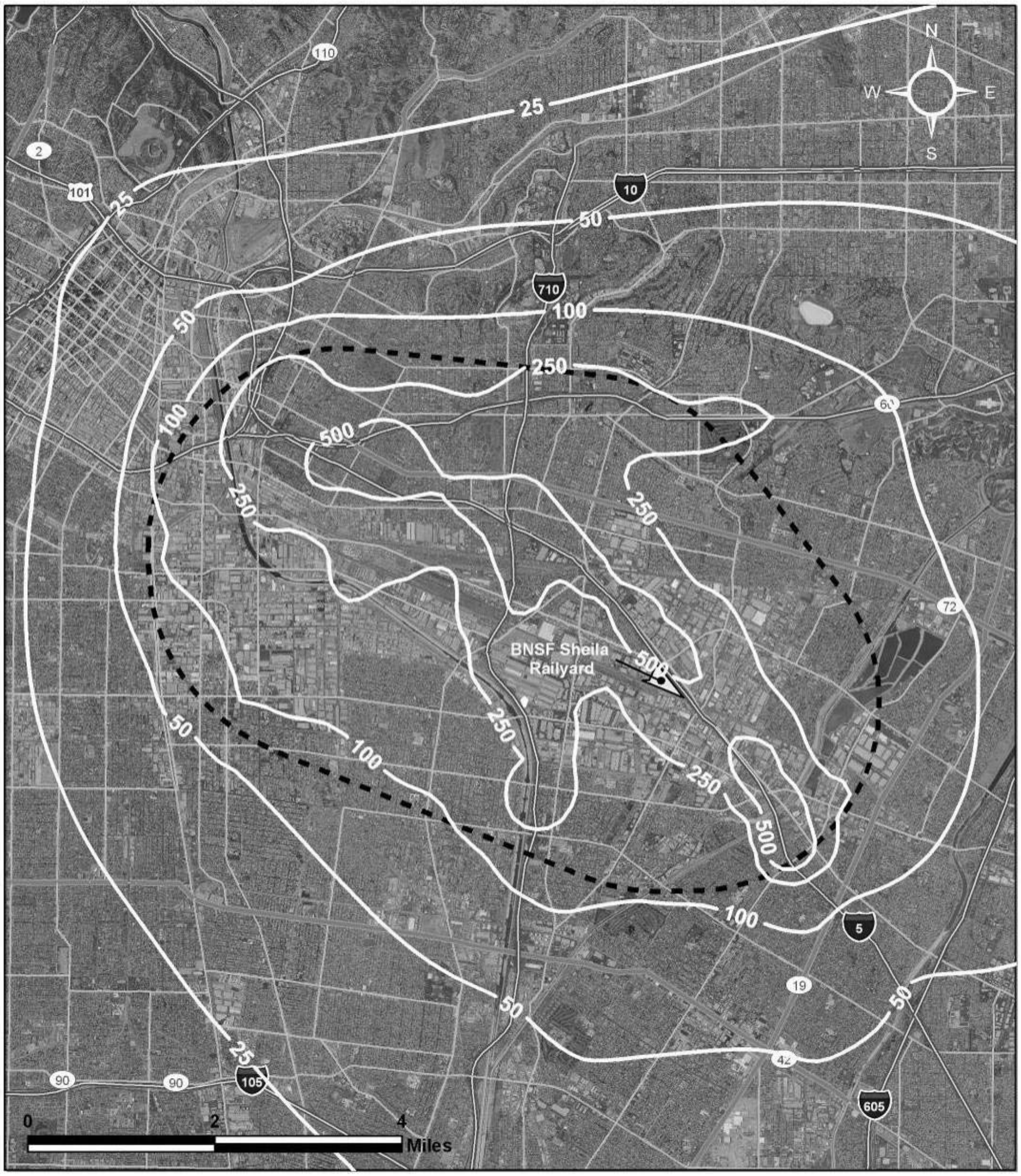


Figure II-5 Estimated potential cancer risk isopleths (chances in a million) associated with diesel PM emissions within the two-mile joint off-site boundary (dashed line), based on 80th percentile breathing rate and 70-year exposure.

Table II-7 Estimated impacted areas and exposed population associated with different cancer risk levels associated with the off-site diesel PM emissions within the two-mile joint off-site boundary (based on 80th percentile breathing rate and 70-year exposure).

Estimated Cancer Risk (cases per million)	Impacted Area (Acres)	Estimated Population Exposed
10 - 25	126,000*	650,000*
25 - 50	25,420*	529,000*
50 - 100	18,070	303,000
100 - 250	17,350	285,000
250 - 500	8,610	100,000
>500	2,330	45,000

*: Approximate estimates due to the fact that part of the isopleths exceed the modeling domain.

G. Can study estimates be verified by air monitoring?

Currently, there is no approved specific measurement technique for directly monitoring diesel PM emissions in the ambient air. This does not preclude the use of an ambient monitoring program to measure general air quality trends in a region. Since cancer risk is based on an annual average concentration, a minimum of a year of intensive monitoring data would generally be needed.

H. What activities are underway to reduce diesel particulate matter emissions and public health risks?

The ARB has developed an integrated approach to reduce statewide locomotive and railyard emissions through a combination of voluntary agreements, ARB and U.S. EPA regulations, incentive funding programs, and early replacement of California's line haul and yard locomotive fleets. California's key locomotive and railyard air pollution control measures and strategies are summarized below:

South Coast Locomotive NOx Fleet Average Agreement (1998): Signed in 1998 between ARB and both Union Pacific Railroad (UP) and BNSF Railway (BNSF), it requires the locomotive fleets that operate in the South Coast Air Quality Management District (SCAQMD) to meet, on average, U.S. EPA's Tier 2 locomotive emissions standards by 2010. This measure will provide an estimated 65% reduction in oxides of nitrogen (NOx) and 50% reduction in locomotive particulate matter emissions in the South Coast Air Basin (SCAB) by 2010.

Statewide Railroad Agreement (2005): ARB and both UP and BNSF signed a voluntary statewide agreement in 2005. When fully implemented, the Agreement is expected to achieve a 20 percent reduction in locomotive diesel PM emissions in and around railyards through a required number of short-term and long-term measures. As of January 1, 2007, ARB staff estimated that the Agreement has reduced diesel PM emissions by 15% in and around the railyard.

ARB Diesel Fuel Regulations Extended to Intrastate Locomotives (2007): This regulation, approved in 2004, requires intrastate locomotives to use only California ultra low sulfur (15 parts per million) and aromatics diesel fuel. CARB diesel fuel can reduce intrastate locomotive diesel PM and NOx emissions by up to 14% and 6%, on average, respectively. ARB staff estimates there are over 250 intrastate locomotives currently operating in South Coast Air Basin. The regulation took effect statewide for intrastate locomotives on January 1, 2007.

ARB Cargo Handling Equipment Regulations (2007): This regulation, approved in 2005, requires the control of emissions from more than 4,000 pieces of mobile cargo handling equipment. This regulation is expected to reduce diesel PM and NO_x emissions by up to 80% by 2020. The regulation took effect January 1, 2007.

On-Road Heavy Duty Diesel Trucks Regulations: In January of 2001, the U.S. EPA promulgated a Final Rule to reduce emission standards for 2007 and subsequent model year heavy-duty diesel engines (66 FR 5002, January 18, 2001). These emission standards represent a 90 percent reduction of NO_x emissions, 72% reduction of non-methane hydrocarbon emissions, and 90 percent reduction of PM emissions compared to the 2004 model year emission standards. The ARB adopted similar emission standards and test procedures to reduce emissions from 2007 and subsequent model year heavy-duty diesel engines and vehicles.

Transport Refrigeration Unit (TRU) Air Toxics Control Measure (ATCM): This air toxics control measure is applicable to refrigeration systems powered by integral internal combustion engines designed to control the environment of temperature sensitive products that are transported in trucks, trailers, railcars, and shipping containers. Transport refrigeration units may be capable of both cooling and heating. Estimates show that diesel PM emission factors for transport refrigeration units and transport refrigeration unit gen-set engines will be reduced by approximately 65 percent in 2010 and 92% in 2020. California's air quality will also experience benefits from reduced NO_x emissions and reduced HC emissions. The transport refrigeration unit air toxics control measure is designed to use a phased approach over about 15 years to reduce the PM emissions from in-use transport refrigeration unit and transport refrigeration unit generator set engines that operate in California. The new rule became effective on December 10, 2004.

Proposed On-Road In-Use Truck Regulations:
The California Air Resources Board (ARB or the Board) is proposing a control measure to reduce diesel particulate matter (PM) and oxides of nitrogen (NO_x) emissions from private fleets of on-road heavy-duty diesel-fueled vehicles. This measure includes, but is not limited to, long and short haul truck-tractors, construction related trucks, port hauling trucks, wholesale and retail goods transport trucks, tanker trucks, package and household goods transport trucks, and any other diesel-powered trucks with a gross vehicle weight rating of 14,000 pounds or greater.

Proposed In-Use Port Truck Mitigation Strategies:
The ARB is evaluating a port truck fleet modernization program that will substantially reduce diesel PM and NO_x emissions by 2010, with additional reductions by 2020. There are an estimated 12,000 port trucks operating at the 3 major California ports which are a significant source of air pollution, about 7,075 tons per year of NO_x and 564 tons per day of diesel PM in 2005, and operate in close proximity to communities. Strategies will include the retrofit or replacement of older trucks with the use of diesel particulate filters and a NO_x reduction catalyst system. ARB staff will propose regulatory strategies for ARB Board consideration by the end of 2007 or early 2008.

ARB Tier 4 Off-Road Diesel-Fueled Emission Standards
On December 9, 2004, the Board adopted a fourth phase of emission standards (Tier 4) that are nearly identical to those finalized by the U.S. EPA on May 11, 2004, in its Clean Air Non-road Diesel Rule. As such, engine manufacturers are now required to meet aftertreatment-based exhaust standards for particulate matter (PM) and NO_x starting in 2011 that are over 90% lower than current levels, putting off-road engines on a virtual emissions par with on-road heavy-duty diesel engines.

U.S. EPA Locomotive Emission Standards: Under the Federal Clean Air Act, the U.S. EPA has sole authority to adopt and enforce locomotive emission standards. This federal preemption also extends to the remanufacturing of existing locomotives. The ARB has been encouraging the U.S. EPA to expeditiously require the introduction of Tier 4 locomotives built with diesel particulate filters and selective catalytic reduction. U.S. EPA released the draft Tier 4 rulemaking in March 2007. The final regulations are expected to be approved by early 2008, but are not proposed to be fully effective until 2017.

ARB Goods Movement Emission Reduction Plan (GMERP): Approved in 2006, the GMERP provides goods movement emissions growth estimates and proposed strategies to reduce emissions from ships, trains, and trucks and to maintain and improve upon air quality. Based largely on the strategies discussed, one of the goals of the GMERP is to reduce locomotive NOx and diesel PM emissions by up to 90% by 2020.

California Yard Locomotive Replacement Program: One locomotive strategy identified in the GMERP is to replace California's older switcher yard locomotives (currently about 800) that operate in and around railyards statewide. There are government incentive programs that may be able to assist in funding the replacement of some intrastate locomotives by 2010.

III. SUMMARY OF SHEILA MECHANICAL RAILYARD ACTIVITY AND EMISSIONS

In 2005, the combined diesel PM emissions from the BNSF Sheila Mechanical Railyard and significant off-site emission sources within the two-mile joint off-site boundary from the railyards were estimated at about 116 tons per year. The off-site diesel PM emissions from mobile sources are estimated at approximately 113 tons per year, or about 98% of the total combined emissions. Off-site stationary sources contribute 0.2 tons per year of diesel PM emissions of the total combined emissions. The diesel PM emissions at the BNSF Sheila Mechanical Railyard are estimated at about 2.7 tons per year, accounting for about 2% of the total combined diesel PM emissions.

A. BNSF Sheila Mechanical Railyard Facility and Description

The BNSF Sheila Mechanical Railyard is located at 6300 East Sheila Street in Commerce, California and is approximately 6 miles east of Los Angeles. As shown in Figure II-1, the facility is located in commercial and manufacturing area with several residential areas located within one-mile distance. The facility is bordered by Washington Boulevard to the north, Interstate-5 (I-5) to the east, the adjacent locomotive main line to the south, and commercial properties to the west. The facility is also located within three-mile distance from three majorroadways, including (1) I-710 to the west, (2) I-605 to the east, and (3) highway 60 located to the north. As shown in Figure II-1, there are three other railyards within two miles from the BNSF Sheila Mechanical Railyard: (1) the UP Commerce, (2) the BNSF Hobart, and (3) the BNSF Commerce Eastern Railyards. The land use within 20 x 20 kilometers (the air dispersion modeling domain) of the facility includes residential (57%), commercial/industrial/transportation (22%), shrub/forest/grass land (16%), and other nature land (5%).

B. BNSF Sheila Mechanical Railyard Operations

The BNSF Sheila Mechanical Railyard is a locomotive mechanical facility, consisting of locomotive repair shop, railcar repair shop, inspection/service areas, locomotive fueling platform, storage areas, and an administration building. The locomotive adjacent main line area located south of railyard is used for freight service and commuter rail (AMTRAK and Metrolink). The main railway line runs south and west to the classification yard and includes freight and commuter operations along the same lines.

Activities at the BNSF Sheila Mechanical Railyard include locomotive maintenance, locomotive line haul, locomotive switching, passenger locomotives, track maintenance, portable engines, on-road fleet vehicles, and stationary source activities. The locomotive operation and service are major activities at the railyard facility, and the schematic locations of these activities are presented in Figures III-1 and III-2. Several stationary sources are also located at facility, including a wastewater treatment plant, a fire suppressant system, an emergency generator, gasoline storage-dispensing terminal. The detailed description of the railyard operation activities is presented in the *BNSF Sheila Facility TAC Emission Inventory* (ENVIRON, 2006a).

C. BNSF Sheila Mechanical Railyard Emission Inventory Summary

The BNSF Sheila Mechanical Railyard activity data for the railyard emissions inventory was provided by the BNSF. The methodology used to calculate the diesel PM and other TAC emission factors is based on ARB emission guidelines (ARB, 2006e), locomotive emission factors (Appendix D) and EMFAC-2006 and OFFROAD-2006 emission inventory models. Detailed calculation methodologies and emission factors are described in the emission inventory report (ENVIRON, 2006a).

The total diesel PM emission inventory within the railyard is summarized in Table III-1 by different source categories.

Table III-1 Summary of diesel PM emissions at the BNSF Sheila Mechanical Railyard.

On-site Source Types	Tons per Year†	Percentage†
Locomotive	2.23	83 %
Off-Road Equipment	0.43	16 %
On-Road Vehicle Fleet*	< 0.01	< 0.1 %
Stationary Sources	< 0.01	< 0.1%
Total	2.67	100 %

* Emissions from on-site truck/vehicle activities only, different from off-site truck emission estimates.
† Numbers may not add precisely due to rounding.

1. Locomotive Emissions

There were 14,577 locomotives were serviced in 2005, including fueling, sanding, and lubricant service regardless of other services provided at the facility. Locomotive operations at the BNSF Sheila Mechanical Railyard are divided into four emission categories: (1) basic locomotive services and inspection (i.e., refueling, maintenance, sanding, engine testing, etc.), (2) switching (i.e., moving locomotives and railcars within the yard), (3) freight movements on mainline, and (4) commuter locomotive operations. The main locomotive operations were further divided into activity subcategories to describe the emission modes and spatial allocation, such as locomotive movements, idle, and locomotives in-consist.

According to BNSF, the BNSF interstate locomotives were fueled out of state before they entered the California borders. BNSF estimated a fuel mixture of about 50% CARB-EPA on-road to 50% non-road diesel fuel, based on the refueling data (see the *BNSF Sheila Mechanical Railyard TAC Emission Inventory*, ENVIRON, 2006a). This approach overestimated non-road (i.e., non CARB-EPA diesel fuel) fuel usage, since it disregarded the consumption of out-of-state fuel before arriving California. This was, therefore, a conservative assumption. A more realistic operating scenario would be a fuel mixture of about 75% CARB-EPA on-road to 25% non-road diesel fuel, which would account for substantial volumes of non-road diesel fuel being consumed before arriving in California. By assuming a mixture of 50% CARB-EPA on-road to 50% non-road diesel fuel, BNSF estimated a sulfur content of about 1,050 ppmw.

The locomotive operations data includes the number of engines serviced, and the typical time in notch setting for those engines receiving services. Temporal emission profiles were estimated for each activity based on hourly locomotive counts. The profiles developed accounts for hourly, daily and seasonal temporal variation and is reflected in air dispersion modeling to capture operation variation. Table III-2 summarizes the diesel PM emissions by locomotive operation activities.

Table III-2 Diesel PM emissions by locomotive operation activities.

Operation Activity	**Tons per Year‡**	**Percentage‡**
Services and Inspection	2.03	91 %
Freight Movement	0.12	5 %
Switching	0.05	2 %
Commuter Locomotives	0.03	1 %
Total	2.23	100 %

‡ Numbers may not add precisely due to rounding.

2. Cargo Handling Equipment Operations

There is no cargo handling equipment operation at the railyard facility.

3. On-Road Container Truck Operations

There is no on-road container truck operation at the railyard facility.

4. On-Road Fleet Vehicle Operations

There were 29 fleet vehicles based on the railyard facility according to records from the BNSF, accounting for 0.05 tons diesel PM emissions in 2005.

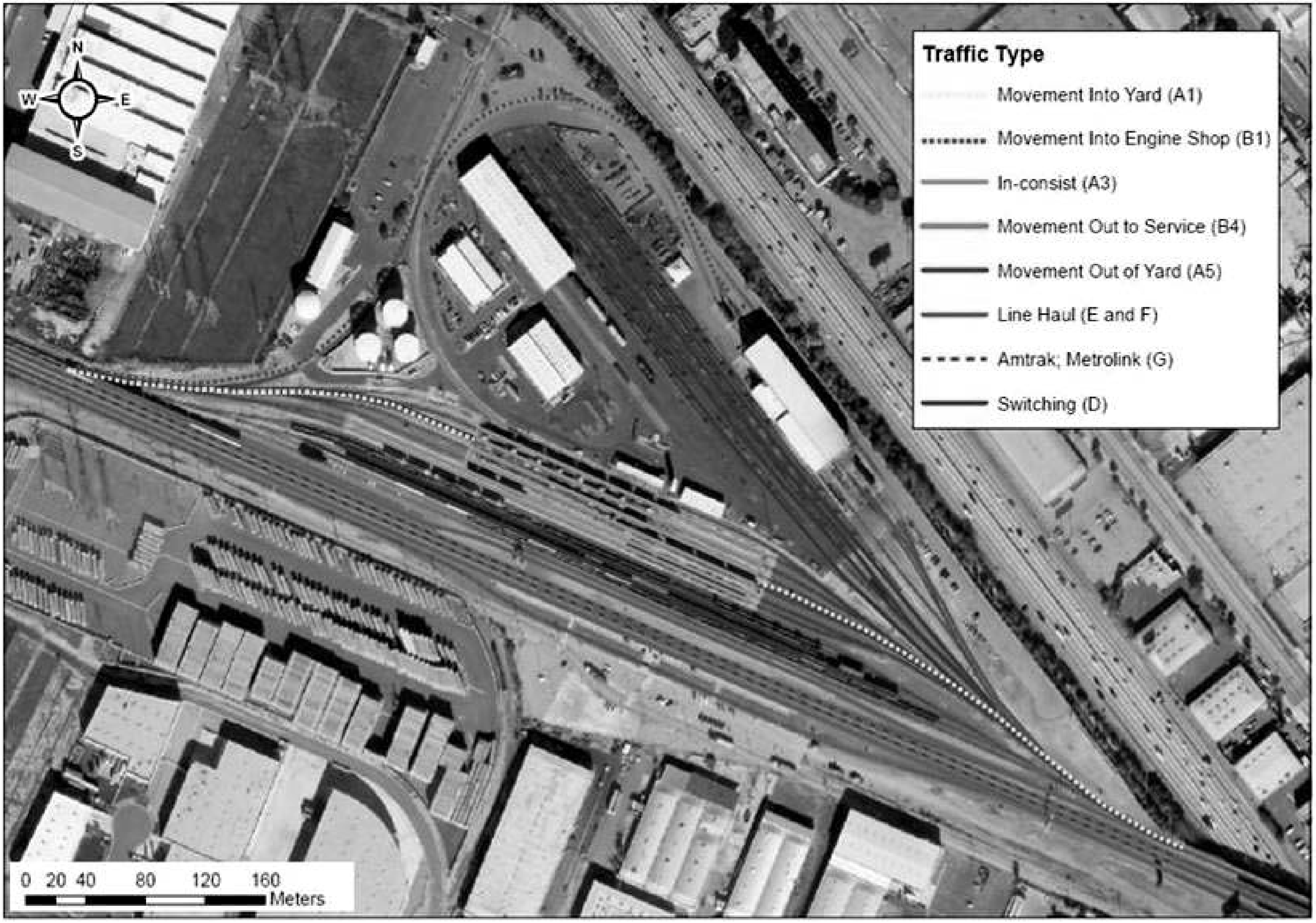


Figure III-1 Locomotive traffic flow at the BNSF Sheila Mechanical Railyard. (Source: ENVIRON, 2006a)

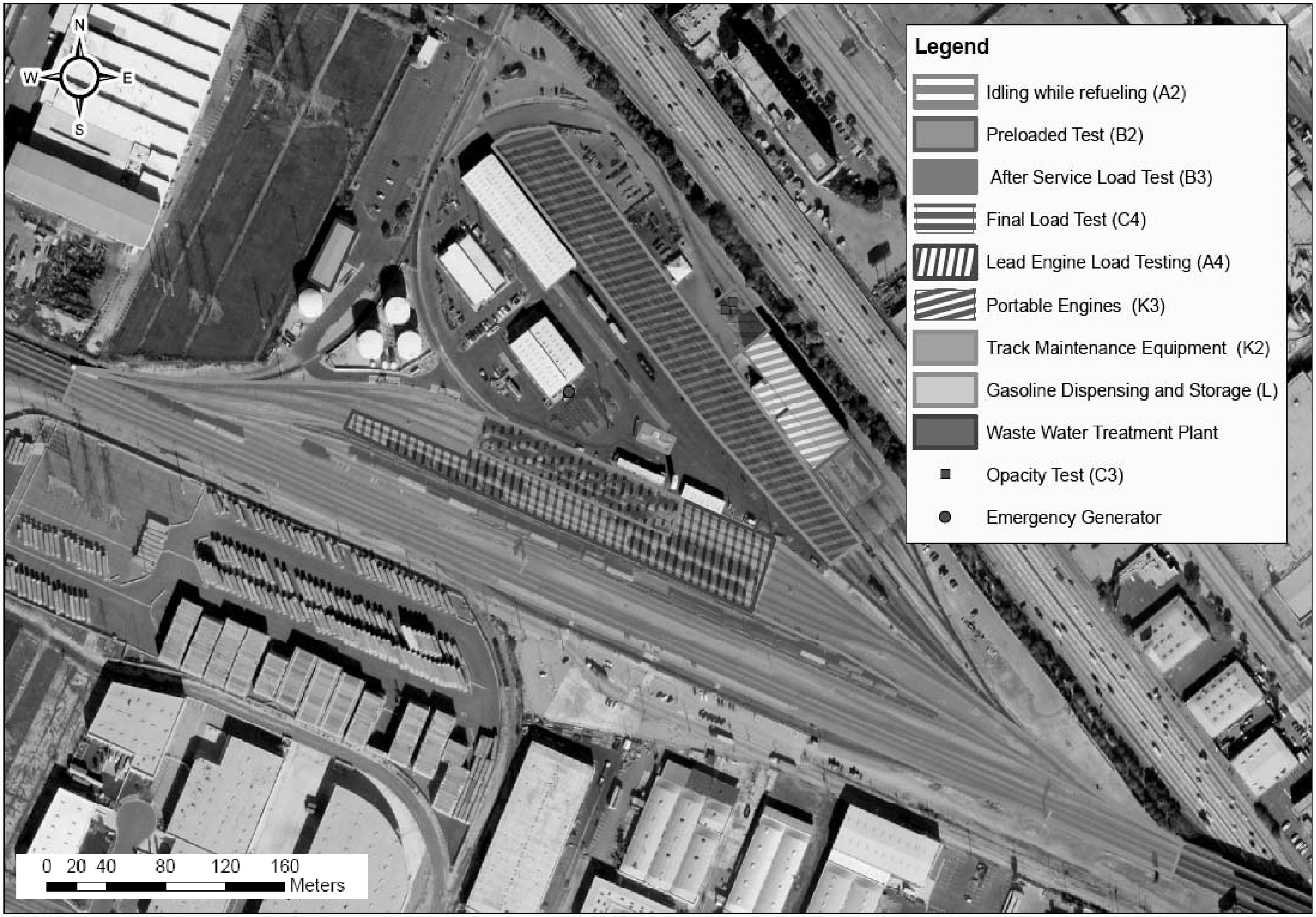


Figure III-2 Locomotive service and maintenance, off-road equipment and stationary sources at the BNSF Sheila Mechanical Railyard. (Source: ENVIRON, 2006a)

5. On-Road Fleet Vehicle Operations

There were 29 fleet vehicles based on the railyard facility according to records from the BNSF, accounting for 0.05 tons diesel PM emissions in 2005.

6. Off-Road and Track Maintenance Equipment

There is no transport refrigeration unit (TRU), container TRU, or boxcars operated at the facility. The activity of diesel-fueled track maintenance equipment and off-road diesel engines accounts for 0.43 tons per year diesel PM emissions.

7. Stationary Sources

The stationary sources at the facility include 3 diesel-fuel storage tanks and 2 diesel-fueled internal combustion engines. The diesel PM emissions generated by this activity was estimated at 10 pounds per year in 2005.

8. Other Toxic Air Contaminant Emissions

The other TACs than the diesel PM associated with the emission source categories described above were estimated based on ARB EMFAC-2006 and OFFROAD-2006 models. The total TAC emissions was estimated at 30 pounds per year, including benzene, formaldehyde, 1,3-butadiene and acetaldehyde from total organic gas (TOG) emissions, presented in Figure III-3. In comparison, these TACs are less than 0.5% of total railyard diesel PM emissions, about 0.01 tons per year. The potential cancer risks contributed by these toxic air contaminants are found to be considerably lower as compared to the diesel PM emissions, about a factor of 330 less, based on cancer potency weighted factor adjustment discussed in Chapter II. Because of the dominance of diesel PM emissions, these TACs generated at the railyard facility are not incorporated into the analysis in the study.

Table III-3 Non-diesel PM emissions (by total organic gases) at the BNSF Sheila Mechanical Railyard.

Activity Source	TOG (Tons per Year)	Percentage
Portable Engines	1.0	85 %
On-Road Fleet Vehicle	0.1	8 %
Track Maintenance Equipment	< 0.01	< 0.1 %
Other Stationary Sources	0.08	7 %
Total	1.17	100 %

D. Off-Site Emission Inventory

ARB staff analyzed the significant off-site emission sources based on two categories: (1) mobile, and (2) stationary. The emissions were estimated for the sources within the two-mile joint off-site boundary of the four Commerce railyards (see Figure II-2).

1. Mobile Sources

For the off-site mobile sources, the analysis focused on heavy duty diesel trucks since they are the primary source of diesel PM from on-road vehicle fleet. ARB staff estimated mobile source emissions based on roadway vehicle activity data and allocated them to roadway links in the area. All roadway links identified within the two-mile joint off-site boundary are included in the analysis. The estimates do not include the diesel PM emissions generated from other modes such as extended idling, starts, and off-road equipment outside the rail yards. Individual sources such as local truck distribution centers and warehouses were not evaluated due to insufficient facility-specific activity data. Their trucking traffic flow outside the facilities but related to their activities is reflected in the roadway link traffic activities on county basis by using the Transportation Demand Models (TDMs) (see Appendix A for details). The off-site diesel PM emissions

Roadway link: is defined as a discrete section of roadway with unique estimates for the fleet specific population and average speed and is classified as a freeway, ramp, major arterial, minor arterial, collector, or centroid connector.

are predominantly generated by mobile sources which emit around 113.2 tons per year. A large portion of the off-site diesel PM emissions are generated from diesel-fueled heavy duty trucks traveling on freeways I-5, I-710, CA-60, I-10 and major local streets. Because the off-site mobile sources have only focused on the on-road diesel emissions, the exclusion of extended idling and off-road equipment may result in an underestimation of off-site mobile sources emissions.

The off-site diesel PM mobile source emissions were estimated based on traffic flow, and calculated by different classifications of truck gross vehicle weights, as shown in Table III-4. For the year 2005, the total diesel PM emissions are estimated at about 113.2 tons per year with 99% of emissions contributed from heavy-heavy duty and medium heavy duty trucks. These two truck classifications account for about 92.7 and 19 tons per year, respectively.

Table III-4 Off-site mobile source diesel PM emissions by vehicle types.

Vehicle Types of Off-Site Mobile Diesel PM Sources	**Gross Vehicle Weight (pounds)**	**Tons per year**	**Percent of Total**
Light-Heavy Duty Diesel Trucks	8,501-14,000	1.5	1%
Medium-Heavy Duty Diesel Trucks	14,001-33,000	19.0	17%
Heavy-Heavy Duty Trucks	> 33,000	92.7	82%
Total		113.2	100%

A great portion of the off-site diesel PM emissions are estimated from diesel-fueled heavy duty trucks traveling on freeways I-5, I-710, CA-60, I-10 and major local streets. Table III-5 presents the distribution of mobile source emissions form the major freeway traffic flows in the area. Out of 113.2 tons per year, the I-5, I-710, CA-60, and I-10 contribute approximately 75.3 tons per year of diesel PM emissions, which accounts for over 66% of total off-site diesel PM mobile source emissions. The remaining 34% or 37.9 tons of mobile diesel PM emissions is contributed from local street traffic flows. The detailed methodology for mobile diesel PM emission estimation is provided in Appendix A.

Table III-5 Off-site diesel PM mobile source emissions from major roadways.

Freeways	Tons per year	Percent of Total Mobile Sources
I-5	40.0	35%
I-710	15.1	13%
CA-60	15.5	14%
I-10	4.7	4%
Total	75.3	66%

2. Stationary Sources

Emissions from off-site stationary sources are identified using the California Emission Inventory Development and Reporting System (CEIDARS) database, which contains information reported by the local air districts. The stationary diesel PM emissions are estimated from diesel-fueled internal combustion engines (ICEs) reported in the CEIDARS database.

Within the two-mile joint off-site boundary, the stationary diesel PM emissions are estimated at about 0.2 tons (approximately 400 pounds) per year, or less than 1% of the total off-site diesel PM emissions. Among total off-site emissions, three major stationary sources, Los Angeles City Department of General Services, City of Vernon Light & Power Department, and Los Angeles County Sheriff's Department, contribute almost 300 pounds per year.

ARB staff also evaluated other toxic air contaminants emissions around the BNSF Sheila Mechanical Railyard within the two-mile joint off-site boundary. There are 2,620 stationary toxic air contaminant sources identified within the joint boundary. The total emissions of toxic air contaminants other than diesel PM emitted were estimated at about 210 tons per year. Among them, ammonia, toluene and methyl chloroform are three major toxic air contaminants with emissions estimated at 57, 25, and 24 tons per year, respectively.

According to ARB' *Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles* (ARB, 2000), diesel PM, 1,3-butadiene, benzene, carbon tetrachloride, formaldehyde are defined as top 5 cancer risk contributors, accounting for 95% of the statewide estimated potential cancer risk levels (ARB, 2000). This study also concluded that diesel PM contributes over 70% percent of the State's estimated potential cancer risk levels, significantly higher than other TACs. Among the off-site TACs emissions, the top cancer risk contributors other than the diesel PM were estimated at about 1.6 tons per year.

The Office of Environmental Health Hazard Assessment has calculated an inhalation cancer potency factor (CPF) for each hazardous compound. The four compounds listed here are given a weighing factor by comparing each compound's CPF to the diesel PM CPF. This factor is multiplied by the estimated actual emissions for that compound, which gives the potency weighted toxic emission as shown in Table II-6. The potency weighted emissions for these toxic air contaminants are estimated at about 0.07 tons per year, and substantially less than the off-site diesel PM emissions. The detailed methodology for the off-site stationary source emission inventory is presented in Appendix B

Cancer potency factors (CPF) are expressed as the upper bound probability of developing cancer assuming continuous lifetime exposure to a substance at a dose of one milligram per kilogram of body weight, and are expressed in units of $(mg/kg\text{-}day)^{-1}$.

Table III-6 Cancer potency weighted toxic air contaminant emissions from off-site stationary sources surrounding the BNSF Sheila Mechanical Railyard within the two-mile joint off-site boundary.

TACs	Cancer Potency Factor	Weighting Factor	Emission (tons/year)	Potency Weighted Toxic Emission (tons/year)
Diesel PM	1.1	1	113.2	113.2
1,3-Butadiene	0.6	0.55	0.007	0.0037
Benzene	0.1	0.09	0.435	0.0392
Carbon Tetrachloride	0.15	0.14	0.001	0.0001
Formaldehyde	0.021	0.02	1.159	0.0244
Total (other than diesel PM)			1.6	0.07

E. Current Available Diesel Fuel Regulations and Their Benefits to the Railyards

1. California Air Resources Board (CARB) Diesel Fuel Specifications

The original California diesel fuel specifications were approved by the Board in 1988 and limited sulfur and aromatic contents. The requirements for "CARB diesel," which became applicable in October 1993, consisted of two basic elements:

- A limit of 500 parts per million by weight (ppmw) on sulfur content to reduce emissions of both sulfur dioxide and directly emitted PM.

- A limit on aromatic hydrocarbon content of 10 volume percent for large refiners and 20 percent for small refiners to reduce emissions of both PM and NO_x.

At a July 2003 hearing, the Board approved changes to the California diesel fuel regulations that, among other things, lowered the maximum allowable sulfur levels in California diesel fuel to 15 ppmw beginning in June 2006. Thus, ARB's specifications for sulfur and aromatic hydrocarbons are shown in Table III-7.

Table III-7 California diesel fuel standards

Implementation Date	Maximum Sulfur Level (ppmw)	Aromatics Level (% by volume)	Cetane Index
1993	500	10	N/A
2006	15	10	N/A

The regulation limiting aromatic hydrocarbons also includes a provision that enables producers and importers to comply with the regulation by qualifying a set of alternative specifications of their own choosing. The alternative formulation must be shown, through emissions testing, to provide emission benefits equivalent to that obtained with a 10 percent aromatic standard (or in the case of small refiners, the 20 percent standard). Most refiners have taken advantage of the regulation's flexibility to produce alternative diesel formulations that provide the required emission reduction.

2. U.S. EPA On-Road Diesel Fuel Specifications

The United States Environmental Protection Agency (U.S. EPA) has also established separate diesel fuel specifications for on-road diesel fuel and off-road (non-road) diesel fuel. The initial U.S. EPA diesel fuel standards were applicable in October 1993. The

U.S. EPA regulations prohibited the sale or supply of diesel fuel for use in on-road motor vehicles, unless the diesel fuel had a sulfur content no greater than 500 ppmw. In addition, the regulation required on-road motor-vehicle diesel fuel to have a cetane index of at least 40 or have an aromatic hydrocarbon content of no greater than 35 percent by volume (vol. %). All on-road motor-vehicle diesel fuel sold or supplied in the United States, except in Alaska, must comply with these requirements. Diesel fuel, not intended for on-road motor-vehicle use, must contain dye solvent red 164.

On January 18, 2001, the U.S. EPA published a final rule which specified that, beginning June 1, 2006, refiners must begin producing highway diesel fuel that meets a maximum sulfur standard of 15 ppmw for all and later model year diesel-fueled on-road vehicles The current U.S. EPA on-road diesel fuel standard is shown in Table III-8.

3. U.S. EPA Non-Road Diesel Fuel Specifications

Until recently, fuel supplied to outside of California was allowed a sulfur content of up to 5,000 ppmw (parts per million by weight). However, in 2004, the U.S. EPA published a strengthened rule for the control of emissions from non-road diesel engines and fuel. The U.S. EPA rulemaking requires that sulfur levels for non-road diesel fuel be reduced from current uncontrolled levels of 5,000 ppmw ultimately to 15 ppmw, though an interim cap of 500 ppmw is contained in the rule. Beginning June 1, 2007, refiners are required to produce non-road, locomotive, and marine diesel fuel that meets a maximum sulfur level of 500 ppmw. This does not include diesel fuel for stationary sources. In 2010, non-road diesel fuel will be required to meet the 15 ppmw standard except for locomotives and marine vessels. In 2012, non-road diesel fuel used in locomotives and marine applications must meet the 15 ppmw standard. The non-road diesel fuel standards are shown in Table III-8.

Table III-8 U.S. EPA diesel fuel standards

Applicability	Implementation Date	Maximum Sulfur Level (ppmw)	Aromatics Maximum (% by volume)	Cetane Index‡ (Minimum)
On-Road	2006	15	35	40
Non-road *	1993	5,000	35	40
Non-road *	2007	500	35	40
Non-road, excluding loco/marine *	2010	15	35	40
Non-road, loco/marine*	2012	15	35	40

* Non-road diesel fuels must comply with ASTM No. 2 diesel fuel specifications for aromatics and cetane index.

‡ A measure of the combustion quality of diesel fuel via the compression ignition process.

4. What are the Current Properties of In-Use Diesel Fuel?

Table III-9 shows average in use level of sulfur content and four other properties for motor vehicle diesel fuel sold in California after the California and Federal diesel fuel regulation became effective in 1993. The corresponding national averages are shown for the same properties for on-road diesel fuel only since the U.S. EPA sulfur standard does not apply to off-road or non-vehicular diesel fuel. Non-road diesel fuel levels have been recorded as about 3,000 ppmw in-use and similar levels as U.S. EPA on-road diesel fuel for aromatics at about 35 percent by volume in-use.

Table III-9 Average 1999 properties of reformulated diesel fuel.

Property	California	U.S.(1)
Sulfur, ppmw	10(2)	10 (2)
Aromatics, vol.%	19	35
Cetane No.	50	45
PNA(3), wt.%	3	NA
Nitrogen, ppmw	150	110

(1) U.S. EPA, December 2000.
(2) Based on margin to comply with 15 ppmw sulfur standards in June 2006.
(3) Polynuclear aromatics.

5. What are the Current Properties of In-Use Diesel Fuel?

The ARB Board approved a regulation in November 2004 which extended the CARB diesel fuel requirements to intrastate locomotives (those operating 90 percent or more of the time in California) effective on January 1, 2007. UP and BNSF agreed in the 2005 railroad Agreement to dispense only CARB diesel or U.S. EPA on-road diesel fuels to interstate locomotives that fuel in California beginning on January 1, 2007.

Line haul locomotives have a range of about 800 to 1,200 miles between fuelings. BNSF locomotives typically refuel at Belen, New Mexico before traveling to Barstow, California and UP locomotives typically refuel at Salt Lake City, Utah before traveling to Roseville in northern California or Colton in southern California. These major out-of-state railroad facilities have the option to use Federal non-road diesel fuels for the refueling of line haul locomotives. When these out-of-state line haul locomotives arrive in California they typically have about 10 percent remaining volume of diesel fuel relative to their tank capacity.

UP and BNSF surveyed each of the California fueling centers, and major interstate fueling centers to California, to estimate the average diesel fuel properties for locomotives for the railyard health risk assessments. Diesel fuel sulfur levels were estimated to be an average of 1,100 ppmw based on the mixture of CARB, U.S. EPA on-road, and non-road diesel fuel consumed by locomotives in California in 2005. ARB staff believes this is a conservative estimate for the types of diesel fuels and sulfur levels consumed by locomotives in California.

The U.S. EPA on-road and CARB on and off-road diesel ultra low sulfur specifications (15 ppmw) went into effect on June 1, 2006. The CARB diesel fuel requirements for intrastate locomotives went into effect on January 1, 2007. The U.S. EPA non-road diesel fuel sulfur limit will drop from 5,000 ppmw to 500 ppmw on June 1, 2007. In 2012, the non-road diesel fuel limits for used in locomotives and marines will drop from 500 ppmw to 15 ppmw.

The NOx emission benefits associated with the use of CARB diesel compared to U.S. EPA on-road and non-road diesel fuels are due to the CARB aromatic hydrocarbon limit of 10 percent by volume or an emission equivalent alternative formulation limit. ARB staff estimates that use of CARB diesel provides a 6 percent reduction in NOx and a 14 percent reduction in particulate emissions compared with the use of U.S. EPA on-road and non-road diesel fuels. In addition, CARB diesel fuel will provide over a 95 percent reduction in fuel sulfur levels in 2007 compared to U.S. EPA non-road diesel fuel. This reduction in diesel fuel sulfur levels will provide SOx emission reductions, and additional PM emission reductions by reducing indirect (secondary formation) PM emissions formed from SO_x.

In addition, the ARB, UP and BNSF Railroads entered into an agreement in 2005 which requires at least 80 percent of the interstate locomotives must be fueled with either CARB diesel or U.S. EPA on-road ultra low sulfur diesel fuel by January 1, 2007. Both the CARB diesel fuel regulation for intrastate locomotives and the 2005 Railroad Agreement for interstate locomotives require the use of ultra low sulfur diesel fuel in 2007, five years earlier than the U.S. EPA non-road diesel fuel regulations for locomotives in 2012.

6. Diesel Fuels Used by Locomotives

Both the U.S. EPA and CARB diesel fuels had sulfur levels lowered from 500 ppmw to 15 ppmw on June 1, 2006. Under the prior sulfur specification of 500 ppmw, CARB diesel fuel in-use sulfur levels averaged around 140 ppmw versus U.S. EPA on-road sulfur levels of about 350 ppmw. With the 2006 implementation of the 15 ppmw sulfur levels, in-use levels for both CARB diesel and U.S. EPA on-road now average about 10 ppmw.

Sulfur oxides and particulate sulfate are emitted in direct proportion to the sulfur content of diesel fuel. Reducing the sulfur content of diesel fuel from the California's statewide average of 140 ppmw to less than 10 ppmw would reduce sulfur oxide emissions by about 90 percent or by about 6.4 tons per day from 2000 levels. Direct diesel particulate matter emissions would be reduced by about 4 percent, or about 0.6 tons per year in 2010 for engines not equipped with advanced particulate emissions control technologies. U.S. EPA on-road lower sulfur diesel fuel would provide similar levels of sulfur oxide and direct diesel particulate matter emission reductions.

The emissions reductions would be obtained with low sulfur diesel used in mobile on-road and off-road engines, portable engines, and those stationary engines required by district regulations to use CARB diesel. In addition, NOx emissions would be reduced by 7 percent or about 80 tons per year for those engines not currently using CARB diesel, assumed to be about 10 percent of the stationary engine inventory and including off-road mobile sources such as interstate locomotives.

The lower sulfur diesel makes much more significant emissions reductions possible by enabling the effective use of advanced emission control technologies on new and retrofitted diesel engines. With these new technologies, emissions of diesel particulate matter and NOx can be reduced by up to 90 percent. Significant reductions of non-methane hydrocarbons and carbon monoxide can also be achieved with these control devices.

IV. AIR DISPERSION MODELING OF BNSF SHEILA MECHANICAL RAILYARD

Air dispersion modeling is conducted to estimate the downwind dispersion of diesel PM emissions estimated from the on-site sources at the BNSF Sheila Mechanical Railyard. A description of the air quality modeling parameters is provided in this chapter, including air dispersion model selection, estimated emissions, meteorological data selection, model receptor network, and building wake effects. The air dispersion modeling for the off-site diesel PM emissions is also conducted and documented in Appendix C.

A. Air Dispersion Model Selection

Air dispersion models are often used to simulate atmospheric processes for applications where the spatial scale is in the tens of meters to tens of kilometers. Selection of air dispersion models depends on many factors, such as characteristics of emission sources (point, area, volume, or line), the type of terrain (flat or complex) at the emission source locations, and source-receptor relationships. For air dispersion modeling, ARB staff selected the U.S. EPA's newly approved air dispersion model AERMOD to estimate the impacts associated with diesel PM emissions in and around the railyard. AERMOD represents for American Meteorological Society / Environmental Protection Agency Regulatory Model Improvement Committee (**AER**MIC) **MOD**EL. It is a state-of-science air dispersion model and is a replacement for its predecessor, the U.S. EPA Industrial Sources Complex (ISC) air dispersion model.

AERMOD is a regulatory air dispersion model specified by the *U.S. EPA Guideline for Air Quality Methods (*40 CFR Part 51, Appendix W*)* (U.S. EPA, 2005). AERMOD is also the recommended model in the *ARB Health Risk Assessment Guidance for Railyard and Intermodal Facilities* (ARB, 2006b).

AERMOD is a steady-state plume model that incorporates current concepts about air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain. These approaches have been designed to be physically realistic and relatively simple to implement

B. Source Characterization and Parameters

The emission sources from the locomotives and other mobile sources at the BNSF Sheila Mechanical Railyard are characterized as either a point source or a volume source depending on whether they are stationary or moving. When a mobile source is stationary, such as when it is idling or undergoing load testing, the emissions are simulated as a series of point sources. Model parameters for point sources include emission source height, diameter, exhaust temperature, exhaust exit velocity, and emission rate.

The locomotive exhaust temperatures and stack heights vary by locomotive makes, models, notch settings and operation time. While the BNSF assumed more specific temperatures and stack heights from their switchers and line haul locomotives fleets, the UP used data from the Roseville Railyard Study (ARB, 2004) based on the most prevalent locomotive model of switchers and line hauls to parameterize locomotive emission settings. In total, the assumptions on the locomotive emission parameters are slightly different between UP and BNSF; however, both are within reasonable ranges according to their activities, and the slight differences in stack height have an insignificant impact on predicted air concentrations, within 2 percent, based on a sensitivity analysis conducted by ARB staff.

According to the BNSF, some locomotives at the Sheila Mechanical Railyard had been equipped with AESS (automatic engine start-stop) or SmartStart device (by ZTR Control System) in 2005. However, the BNSF used a more conservative approach that did not incorporate the benefits of using the devices in the locomotive emissions estimation. ARB staff believes that the BNSF's approach is more protective in terms of health impacts.

When a mobile source is stationary, such as when it is idling or undergoing load testing, the emissions are simulated as a series of point sources. Model parameters for point sources include emission source height, diameter, exhaust temperature, exhaust exit velocity, and emission rate. When a mobile source is traveling, the emissions are simulated as a series of volume sources to mimic the effects of initial dispersion due to plume downwash. Key model parameters for volume sources include emission rate (or strength), source release height, and initial lateral and vertical dimensions of volumes.

The emissions from all stationary sources (storage tanks, sand tower, wastewater treatment plant, etc.) and portable sources (welders, steam cleaners, air compressors, etc.) are simulated as a series of point sources.

The emission rates for individual locomotives are a function of locomotive type, notch setting, activity time, duration, and operating location. Emission source parameters for locomotive model classifications at the yard, including emission source height, diameter, exhaust temperature, and exhaust velocity, were provided by the BNSF Railways. Since the stationary locomotives were not uniformly distributed throughout the yard, the locations of individual locomotive emission sources used for the model inputs were determined based on the detailed locomotive distribution and activity information from the BNSF.

C. Meteorological Data

The AERMOD model requires meteorological parameters to characterize air dispersion dynamics in the atmosphere. Wind direction determines where pollutants will be transported and wind speed determines how rapidly the pollutant emissions will be diluted in air. The meteorological variables also influence emission plume rise, thus affecting downwind concentrations of pollutants. Under low wind conditions, the plume's initial buoyancy and inertia will cause the emissions to go higher into the air than during high wind conditions. Atmospheric stability determines the rate of mixing in the atmosphere and is typically characterized by the atmospheric vertical temperature profile. The difference of ambient temperature and the emission source exhaust exit temperature determines the initial buoyancy. In general, the greater the temperature difference, the higher the plume rise. In addition, the opaque cloud cover and upper air sounding data are used in calculations to determine other important dispersion parameters. These include atmospheric stability (a measure of turbulence and the rate at which pollutants disperse laterally and vertically) and mixing height (the vertical depth of the atmosphere within which dispersion occurs). The greater the mixing height is, the larger the volume of atmosphere is available to dilute the pollutant concentration.

Meteorological data used in the model are selected on the basis of representativeness of meteorological features to the facility. Representativeness is determined primarily on whether the wind speed and direction distributions and atmospheric stability estimates generated through the use of a particular met station (or set of stations) are expected to mimic those actually occurring at a location where such data are not available. Typically, the key factors for determining representativeness are proximity of the meteorological station and the presence or absence of nearby terrain features that might alter airflow patterns. The area surrounding the BNSF Sheila Mechanical Railyard is generally flat and would not be expected to exhibit significant variations in wind patterns within relatively short distances. The dominant terrain features/water bodies that may influence wind patterns in this part of the Los Angeles Basin include the hills to the north and east and the Pacific Ocean further to the west. Meteorological stations that collect wind speed, wind direction, temperature, and pressure data in the region of the BNSF Sheila Mechanical Railyard include: Lynwood, Los Angeles-North Main Street, and Pico Rivera, operated by South Coast Air Quality Management District (SCAQMD); and the station at University of Southern California (USC) Campus in Los Angeles, operated by National Weather Service (NWS).

The meteorological data recorded at the Pico Rivera station and Los Angeles-North Main Street station appear to be influenced by local terrain variations due to the nearby hills. Based on ARB's criteria (ARB, 2006b), the Lynwood station was determined as the most representative meteorological station for the BNSF Sheila Mechanical Railyard. However, the Lynwood station did not record temperature and cloud cover data from 2000 to 2005. Therefore, hourly wind speed and direction data from the Lynwood station, and temperature and cloud cover data from the Los Angeles downtown USC station were selected for the AERMOD modeling. The upper air sounding data were chosen from the San Diego-Miramar NAS stations.

Surface parameters supplied to the model were specified for the area surrounding the surface meteorological monitoring site as recommended by AERMOD and ARB

Guidelines (ARB, 2006b). According to the sensitivity analyses conducted by BNSF, the impacts on the diesel PM air concentration predictions by using the long-term (i.e., five-year) vs. short-term (i.e., one-year) are found to be insignificant. This is consistent with the findings from a sensitivity analysis from one of UP railyards conducted by ARB staff (see Appendix G). Therefore, whether five-year or one-year meteorological data are used, the modeling results show similar estimated exposures and potential cancer risks surrounding the railyard facility. Detailed description of meteorological data selection is discussed in *Air Dispersion Modeling Assessment of Air Toxic Emissions from BNSF Sheila Mechanical Railyard* (ENVIRON, 2006a).

Figure IV-1 and IV-2 show the wind rose plots and the wind class frequency distributions for the meteorological data used for the air dispersion modeling in this study. The yearly average wind speed is estimated at 1.9 meters per second. The prevailing wind shows a southwesterly dominance in the region. The detailed procedures of meteorological data preparation and the QA/QC are also documented in the air dispersion modeling report (ENVIRON, 2006b).

***Wind rose**: a rose-like shape plot that depicts wind speed and direction patterns to illustrate prevailing wind.*

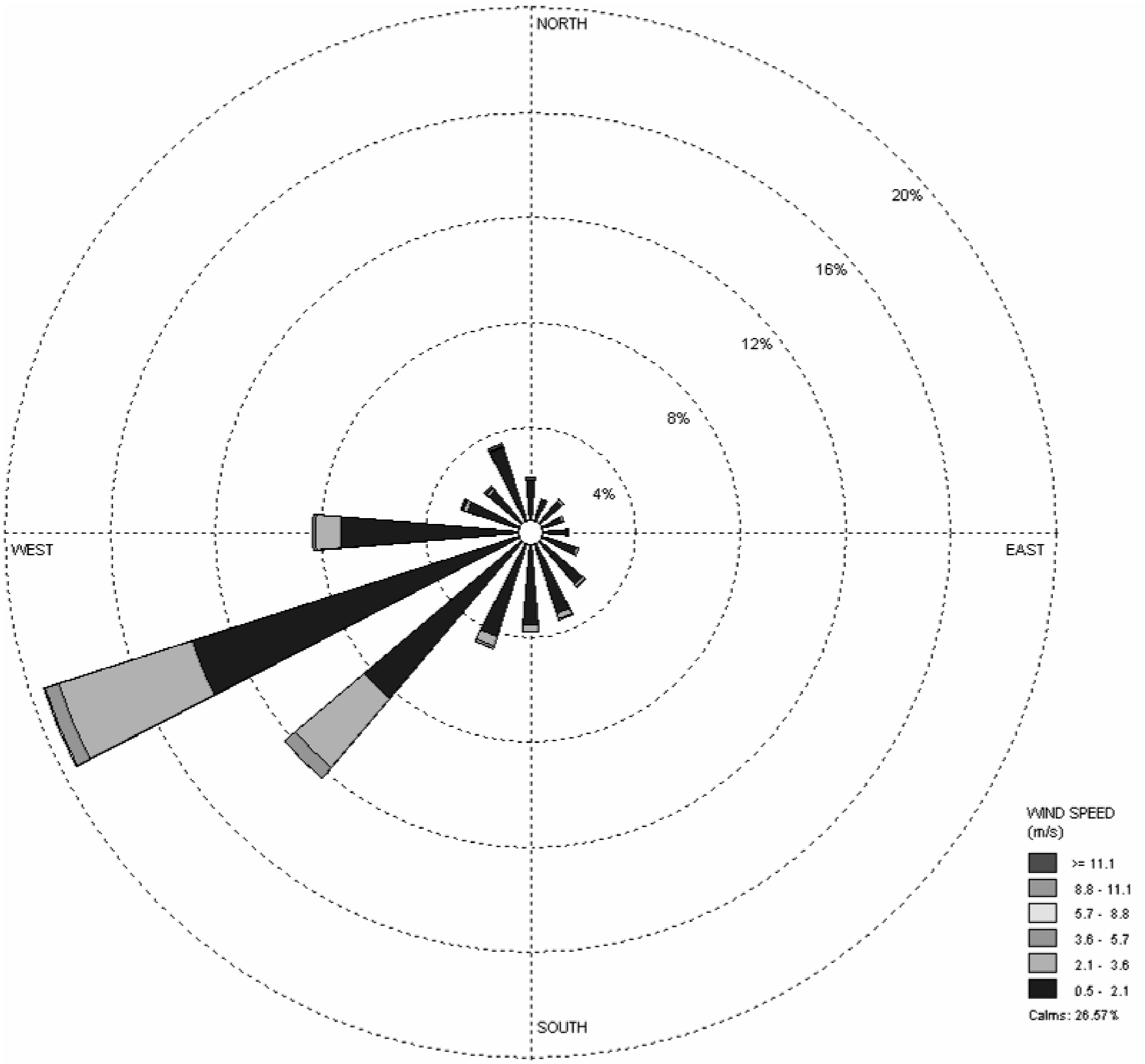


Figure IV-1 Wind rose plot of Lynnwood meteorological station for 2001–2005.

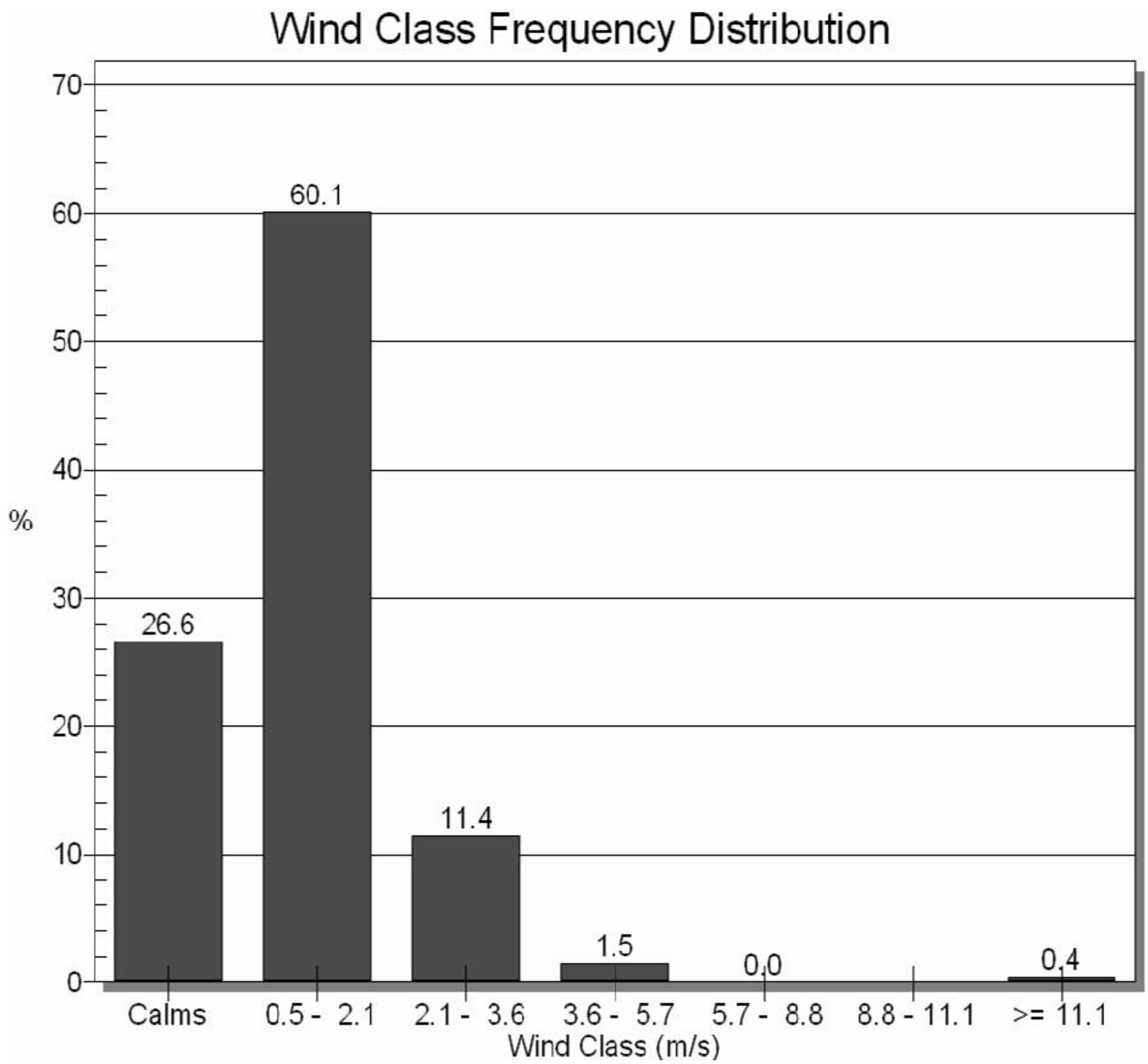


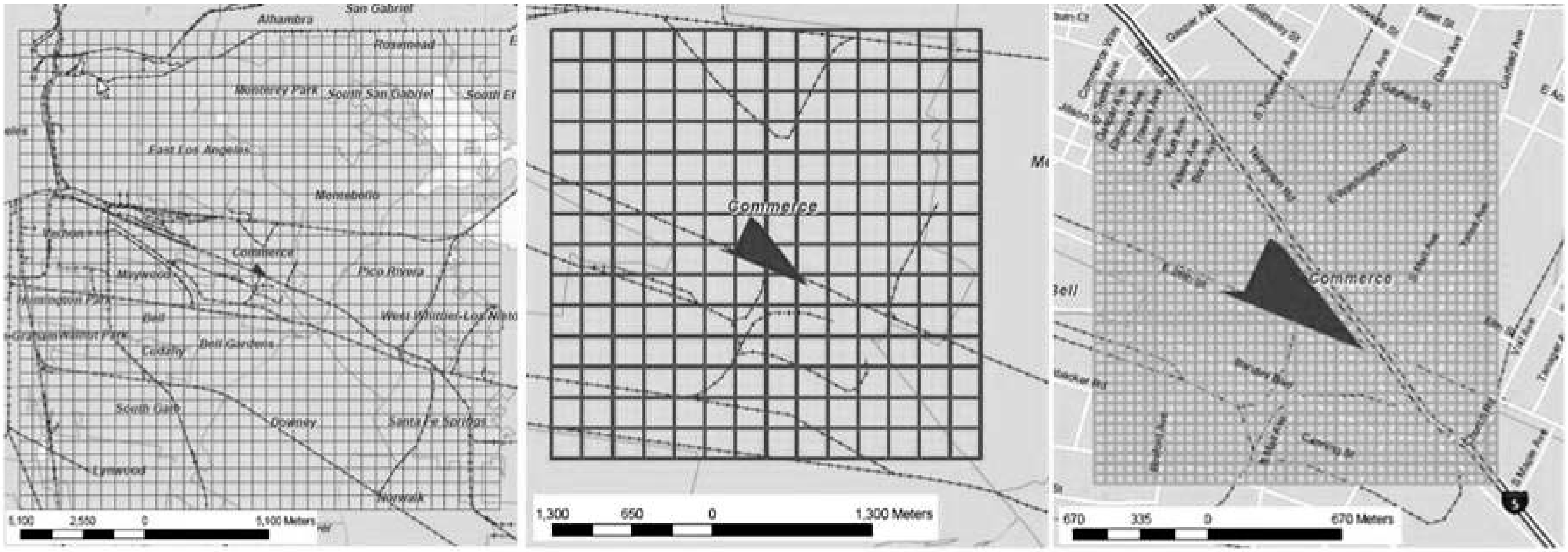
Figure IV-2 Wind class frequency distribution recorded at Lynnwood meteorological station for 2001–2005.

D. Model Receptors

Receptors are the defined discrete locations where concentrations are estimated by the dispersion model. A Universal Transverse Mercator (UTM) coordinate grid receptor network is used in the study where an array of points are identified by their coordinates. This network is capable of identifying the emission sources within the railyard with respect to the receptors in the nearby areas. According to the ARB Railyard Health Risk Assessment Guidance (ARB, 2006b), the modeling domain is defined as a 20x20 kilometer region, which covers the railyard in the center of domain and extends to the surrounding areas. The ARB's Guidance requires coarse and fine modeling receptor grids. However, a medium receptor grid were used to better capture the different concentration gradients surrounding the railyard area. Three Cartesian receptor networks used in model simulations include a fine receptor grid with spacing of 50 meters out to a distance of approximately 750 meters from the facility boundary, a medium receptor grid with spacing of 250 meters out to a distance of approximately 1,500 meters from the facility boundary, and a coarse receptor grid with spacing of 500 meters out to ten kilometers from the facility boundary. The locations of the coarse, medium and fine receptor grid networks are presented in Figures IV-3a, IV-3b, and IV-3c, respectively.

E. Building Wake Effects

One of characterizations in the air dispersion model is mixing process of air pollutants due to the air flow cause by surrounding environment. The spacing and placement of emission sources relative to surrounding building or structures can have such an effect on the pollutant plume in the air. If pollutant emissions are released at or below the Good Engineering Practice (GEP) height as defined by EPA Guidance (US EPA, 1985), the plume dispersion may be affected by surrounding facility buildings and structures. The aerodynamic wakes and eddies produced by the buildings or structures may cause pollutant emissions to be mixed more rapidly to the ground, causing elevated ground level concentrations. The AERMOD model has the option to simulate the effects of building downwash. To do so, "direction-specific" building dimensions for each emission point need to be input. The direction-specific building dimensions represent the building width perpendicular to the wind direction along with the building height, and are estimated by a model built-in module, the Building Profile Input Program – Plume Rise Model Enhancements, to account for potential building-induced aerodynamic downwash effects. Although all BNSF railyards included building wake effects in their modeling analyses, BNSF conducted a sensitivity analysis and found that the building wake effect has an insignificant impact on the diesel PM air concentrations of the railyard (ENVIRON, 2006b)



(a) (b) (c)

Figure IV-3 The receptor grid networks of air dispersion modeling at the BNSF Sheila Mechanical Railyard facility. (a: coarse grid; b: medium grid; c: fine grid. Source: Air Dispersion Modeling Assessment of Air Toxic Emissions from BNSF Sheila Mechanical Railyard, ENVIRON, 2006b)

A sensitivity analysis was conducted to estimate the impact of building downwash from locomotive engines on stationary locomotive sources. This sensitivity analysis indicated that, at receptor distances close to the sources (i.e., within 100 meters), building downwash may have a large impact on the modeled concentrations. However, at distances further away from the sources (i.e., 400 to 700 meters), receptor concentrations from model predictions with and without building downwash were similar (i.e., within 10% of each other).

F. Model Implementation Inputs

One of the basic inputs to AERMOD is the runstream setup file which contains the selected modeling options, as well as source location and parameter data, receptor locations, meteorological data file specifications, and output options. Another type of basic type of input data needed to run the model is the meteorological data. AERMOD requires two types of meteorological data files. One consists of surface scalar parameters, and the other file consists of vertical profiles of meteorological data. For applications involving elevated terrain effects, the receptor and terrain data will need to be processed by the terrain preprocessing program before input to the AERMOD model.

Source inputs require source identification and source type. Each source type requires specific parameters to define the source. For example, the required details for a point source are emission rate, release height, emission source diameter, exhaust exit temperature, and exhaust exit velocity. The requirements and the format of input files to the AERMOD are documented in the user's guide of AERMOD (US EPA, 2004a).

V. HEALTH RISK ASSESSMENT OF BNSF SHEILA MECHANICAL RAILYARD

This chapter describes the ARB's guidelines on health risk assessment and characterization of potential cancer and non-cancer risks associated with exposure to toxic air contaminants, especially diesel PM emissions from the sources within and surrounding the BNSF Sheila Mechanical Railyard, followed by a discussion of uncertainties with respect to the components of health risk assessment.

A. ARB Railyard Health Risk Assessment (HRA) Guidelines

The railyard HRA follows *The Air Toxics Hot Spots Program Risk Assessment Guidelines* published by OEHHA, and is consistent with the methodologies used for the UP Roseville Railyard Study (ARB, 2004a). The OEHHA Guidelines outline a tiered approach to risk assessment, providing risk assessors with flexibility and allowing for consideration of site-specific differences:

- Tier-1: a standard point-estimate approach that uses a combination of the average and high-end point-estimates.
- Tier-2: utilizes site-specific information for risk assessment when site-specific information is available and is more representative than the Tier 1 point-estimates.
- Tier-3: a stochastic or random approach for exposure assessment when the data distributions are available.
- Tier-4: similar to the Tier 3 approach, but all site-specific data distributions are used.

> ***Percentile****: Any one of the points dividing a distribution of values into parts each of which contain 1/100 of the values. For example, the 65th percentile breathing rate is a value such that the breathing rates from 65 percent of population are less or equal to it.*

The Health Risk Assessment is based on the railyard specific emission inventory and air dispersion modeling predictions. The OEHHA guidelines recommend that all health hazard risk assessments adopt a Tier-1 evaluation for the Hot Spots Program, even if other approaches are also presented. Two point-estimates of breathing rates in Tier-1 methodology are used for this HRA, one representing an average and the other representing a high-end value based on the probability distribution of breathing rate. The average and high-end of point-estimates are defined as 65th percentile and 95th percentile from the distributions identified in the OEHHA guidelines. In 2004, ARB recommended the interim use of the 80th percentile value (the midpoint value of the 65th and 95th percentile breathing rates referred as an estimate of central tendency) as the minimum value for risk management decisions at residential receptors for the breathing intake (ARB, 2004b). The 80th percentile corresponds to a breathing rate of 302 Liters/Kilogram-day (302 L/Kg-day) from the probability distribution function. As indicated by the OEHHA Guidelines, the Tier-1 evaluation is useful in comparing risks among a number of facilities and similar sources.

The ARB has also developed *Health Risk Assessment Guidance for Railyard and Intermodal Facilities* to help ensure that the air dispersion modeling and HRA performed for each railyard meet the OEHHA guidelines. The risk assessment adopted in this study assumes that the receptors (or an individual) will be exposed to the same toxic levels for 24 hours per day for 70 years. If a receptor is exposed for a shorter period of time to a given ambient concentration of diesel PM, the cancer risk will proportionately become less.

B. Exposure Assessment

Exposure assessment is a comprehensive process that integrates and evaluates many variables. Three process components have been identified to have significant influences on the results of a health risk assessment – emissions, meteorological conditions, and exposure duration of nearby residents. The emissions have a linear effect on the risk levels, given meteorological conditions and a defined exposure duration. Meteorological conditions have a critical impact on resultant ambient concentration of a pollutant, with higher concentrations found along the predominant wind direction and under calm wind conditions. An individual's proximity to the emission plume, exposure duration, and the individual's breathing rate also play a key role in determining the potential risk. The longer the exposure time for an individual is, the greater the potential risk for the individual will be. A 70-year (life time) exposure, duration has been assumed for the quantification of health risk for residents in this study. In addition, 40- and 9-year exposure assessments were also conducted for off-site workers and school-aged children. Children have a greater risk than adults, i.e., an early life exposure, because they have greater exposure on a per unit body weight basis and also due to other factors.

Diesel PM is not the only TAC emitted from the BNSF Sheila Mechanical Railyard. Gasoline TACs are also found at the railyard from gasoline-fueled engines and storage tanks. The gasoline emissions were found to be much lower than diesel PM emissions within the BNSF Sheila Mechanical Railyard based on the year 2005 emission inventory. ARB staff also evaluated the health impacts of the diesel PM emissions and other TACs from off-site stationary and mobile sources around the BNSF Sheila Mechanical Railyard.

The relationship between a given level of exposure to diesel PM and the cancer risk is estimated by using the diesel PM cancer potency factor (CPF). A description of how the diesel cancer potency factor was derived can be found in the document of *Proposed Identification of Diesel Exhaust as a Toxic Air Contaminant* (ARB, 1998) and a shorter description can be found in the Air Toxics Hot Spot Program Risk Assessment Guidelines, Part II, Technical Support Document for Describing Available Cancer Potency Factors (OEHHA, 2002). The use of the diesel unit risk factor for assessing cancer risk is described in the OEHHA guidelines. The potential cancer risk is estimated by multiplying the inhalation dose by the CPF of diesel PM, i.e., 1.1 $(mg/kg\text{-}day)^{-1}$.

C. Risk Characterization

Risk characterization is defined as the process of obtaining a quantitative estimate of risk. The process integrates the results of air dispersion modeling and relevant toxicity data (e.g., diesel PM CPF) to estimate potential cancer or non-cancer health impacts associated with contaminant exposure.

Exposures to pollutants usually occur through different intake pathways, such as air breathing, dermal contact, ingestion of contaminated produce, and ingestion of fish that have taken up contaminants from water bodies. These exposures can all contribute to an individual's health risk. However, diesel PM risk is evaluated by the inhalation pathway only because the risk contributions by other pathways of exposure are known to be insignificant compared to the inhalation intake and difficult to quantify. It should be noted that the background or ambient diesel PM concentrations are not incorporated into the risk quantification in this study. Additional details on the risk characterization are provided in the Toxic Hot Spot Program Risk Assessment Guidelines (OEHHA, 2000).

To characterize the risk from the diesel PM emissions, three Cartesian receptor networks are used for the coverage of BNSF Sheila Mechanical Railyard and its surrounding areas, including (1) a fine receptor grid network with spacing of 50 meters out to a distance of approximately 750 meters from the facility boundary, (2) a medium receptor grid with spacing of 250 meters out to a distance of approximately 1,500 meters from the facility boundary, and (3) a coarse receptor grid with spacing of 500 meters out to ten kilometers from the facility boundary. These receptor grid networks are graphically presented in Figure V-3a, V-3b, and V-3c. The risk levels are presented as two-dimensional isopleths (or contours). These isopleths are used to display the risk plume ranges and gradient (or risk changes with distance) in all wind directions.

In the following sections, the cancer risk levels and non-cancer chronic risk levels resulting from on-site and off-site diesel PM emissions will be presented, followed by a discussion of non-cancer acute risk assessment.

D. Risk Characterization Associated with On-Site Emissions

1. Cancer Risk

The operation activities at BNSF Sheila Mechanical Railyard indicates diesel PM emissions are contributed by several sources, including locomotives, on-road diesel fleet vehicles, diesel-powered equipment, portable equipment and other stationary sources.

Figure V-1 shows the isopleths of cancer risk from on-site diesel PM emissions based on the 80th percentile breathing rate approach. The estimated potential cancer risk levels at vicinity of facility range from 10 in a million at about one mile from the railyard perimeter to 250 in a million near the north side of the railyard fence line. Beyond the railyard boundaries, the estimated cancer risk levels show a sharp gradient of decrease on the south and west of railyard due to the southwesterly wind in the region. In contrast, the downwind impacted region with a potential cancer risk exceeding 10 chances per million encompasses a larger area reaching approximately a two and a half mile distance northeast from the railyard. The most residential population near the Sheila Mechanical Railyard would have estimated cancer risks from 10 to 25 chances in a million.

Table V-1 presents cancer risk levels and the associated exposed population for different impacted zones. As shown in Table V-1, the impacted area with a potential cancer risk level from 10 to 50 in a million is estimated approximately at 3100 acres, and exposed population at 30,300. According to the Census 2000 data, most of residential population is located east and north in neighboring areas and along the I-5 on northwest and southeast. Of total exposed population shown in Table V-1, 92% is affected by the potential cancer risks ranging from 10 to 25 in a million. The modeling results also show that residents who reside close to the northwest of railyard have the highest cancer risk among the residential population, estimated at about 40 chances per million.

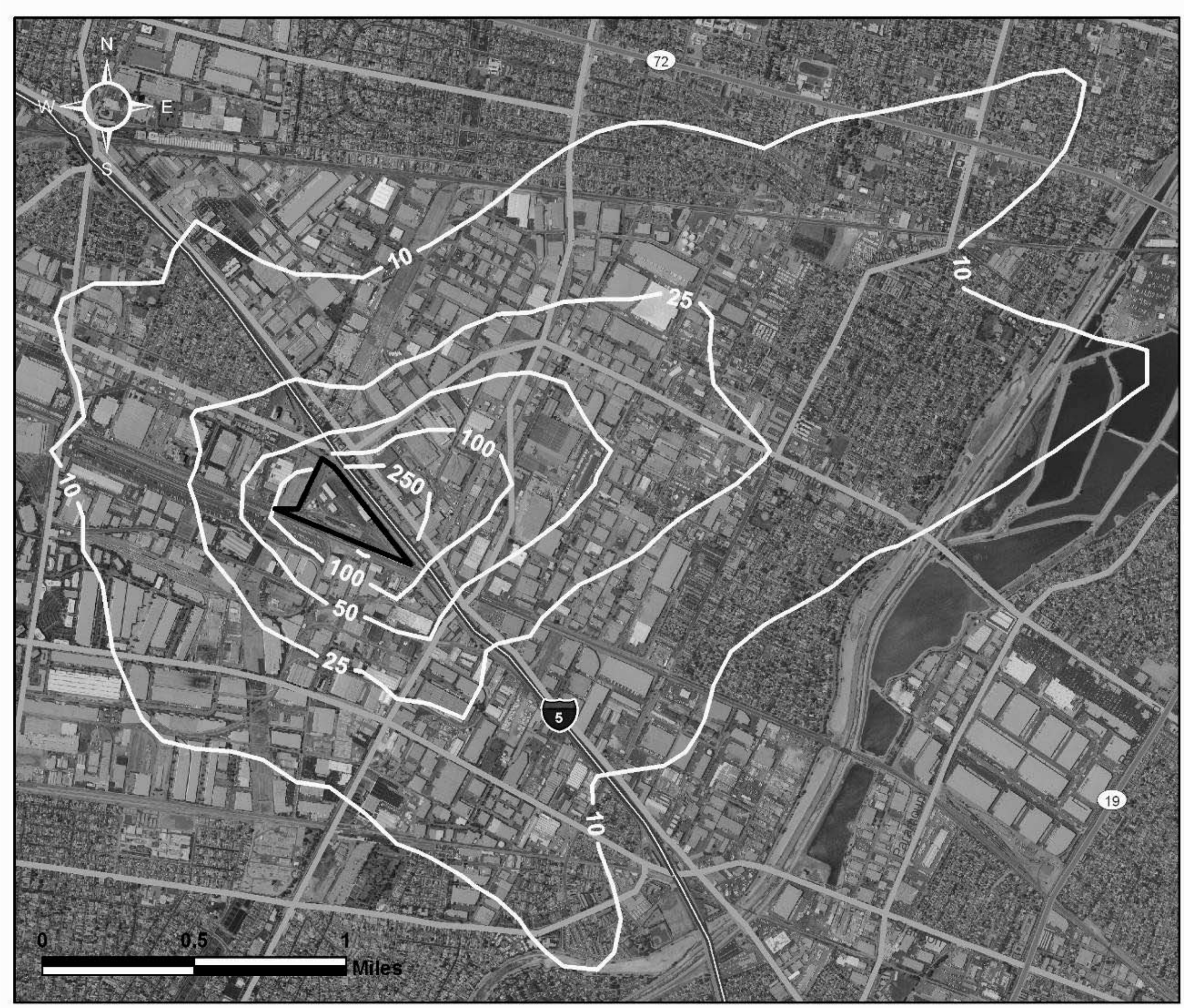


Figure V-1 Estimated potential cancer risks (chances per million) associated with on-site diesel PM emissions at the BNSF Sheila Mechanical Railyard facility (based on 80th percentile breathing rate and 70-year exposure).

Table V-1 Area coverage and exposed population from different estimated cancer risk zones associated with on-site diesel PM emissions.

Impacted Zone (chances per million)	Impacted Area (acres)	Exposed Population
25 - 50	600	2,300
10 - 25	2,600	28,000

The OEHHA Guidelines recommend a 70-year lifetime exposure duration to evaluate the potential cancer risks for residents. Shorter exposure duration of 30 years and 9 years may also be evaluated as supplemental information. These exposure durations are all based on the exposures of 24 hours a day, and 7 days a week. It is important to note that children, for physiological as well as behavioral reasons, have higher rates of exposure than adults on a per unit body weight basis. To evaluate the potential cancer risks for workers, the OEHHA Guidelines recommend that a 40-year exposure duration to be used, assuming workers have a different breathing rate of 149 Liters/Kilogram-day for an 8-hour workday, with adjustments of five days a week and 245 days a year. Table V-2 shows the equivalent risk levels of 70-, 30-year exposure durations for exposed residents, and 40-, 9-year exposure durations for off-site workers and school-aged children, respectively. Using Table V-1, the isopleth line with a risk level of 10 in a million in Figures V-1 would become 4 in a million for exposed population with a shorter residency of 30 years, 2.5 in a million for children at the age range of 0-9 (the first 9-year childhood), and 2 in a million for off-site workers.

Table V-2 Equivalent potential cancer risk levels of 70-, 30-, 9-, and 40-year exposure durations associated with on-site railyard diesel PM emissions (based on Tier-1 methodology).

Exposure Duration (years)	Equivalent Estimated Cancer Risk Levels (chances in a million)			
70	10	25	50	100
30	4	11	21	43
9*	2.5	6.3	12.5	25
40‡	2	5	10	20

* Exposure duration for school-aged children during the first 9-year childhood.
‡ Exposure duration for off-site workers.

The OEHHA Guidelines require that for health risk assessments, the cancer risk for the maximum exposure at the point of maximum impact should be reported. The point of maximum impact (PMI) is a location or the receptor point with the highest cancer risk level outside of the railyard boundary, with or without residential exposure, is predicted to be located at the north side of the railyard fence line. The PMI location for the BNSF Sheila Mechanical Railyard was identified at the northeast of the facility, between the railyard fence line and the Interstate I-5, shown in Figure V-2. This is downwind of high emission density area for the prevailing southwesterly wind, where about 65 percent of facility-wide diesel PM emissions were generated (see the emission allocation in Appendix F). Given the model implemented data, the estimated cancer risk at the PMI is about 490 chances per million for the 70-year exposure. The land use in the vicinity of the PMI is primarily zoned for transportation and industrial use. However, there can be residents potentially to live within this zoned area. In the residential zoned area, the potential cancer risk of maximally exposed individual resident (MEIR) or maximum individual cancer risk (MICR) is estimated at about 40 chances in a million. As indicated by Roseville Railyard Study (ARB, 2004a), the location of the point of maximum impact may vary depending upon the settings of the model inputs and parameters, such as meteorological data set or emission allocations in the railyard. Therefore, given the estimated emissions, modeling settings, and the assumptions applied to the risk assessment, there are great uncertainties associated with the estimation of PMI and MICR. These indications should not be interpreted as a literal prediction of disease incidence but more as a tool for comparison. In addition, the estimated point of maximum impact and maximum individual cancer risk may not be replicated by air monitoring.

ARB staff also conducted a comparison of cancer risks estimated at the PMI versus MICR, and the differences of facility-wide diesel PM emissions between the UP and BNSF railyards. The ratios of cancer risks at the PMI or MICR to the diesel PM emissions do not suggest that one railroad’s facilities have statistically higher cancer risks than the other railroad’s or vice versa. Rather, the differences are primarily due to emission spatial distributions from individual operations among railyards.

In the BNSF Sheila Mechanical Railyard, the total toxic air contaminant emissions other than diesel PM is estimated at about 0.01 tons or 30 pounds per year, including benzene, formaldehyde, 1,3-butadiene and acetaldehyde. Using cancer potency weighting factors adjustment discussed in Chapter II, these non-diesel PM toxic air contaminants have considerably less potential cancer risks, about a factor of 330 less, as compared to the diesel PM generated from the railyard.

2. Non-Cancer Chronic Risk

The quantitative relationship between the amount of exposure to a substance and the incidence or occurrence of an adverse health impact is referred to a dose-response assessment. According to the OEHHA guidelines, dose-response information for non-carcinogens is presented in the form of Reference Exposure Levels (RELs). OEHHA has developed chronic RELs for assessing non-cancer health impacts from long-term exposure.

A chronic REL is a concentration level, expressed in units of micrograms per cubic meter (μg/m^3) for inhalation exposure, at or below which no adverse health effects are anticipated following long-term exposure. Long-term exposure for these purposes has been defined as 12% of a lifetime, or about eight years for humans. The methodology for developing chronic RELs is fundamentally the same as that used by U.S. EPA in developing the inhalation Reference Concentrations (RfCs) and oral Reference Doses (RfDs). Chronic RELs are frequently calculated by dividing the no observed adverse effect level (NOAEL) or lowest observed adverse effect levels (LOAEL) in human or animal studies by uncertainty factors. A substantial number of epidemiologic studies have found a strong association between exposure to ambient particulate matter and adverse health effects. For diesel PM, OEHHA has determined a chronic REL of 5 μg/m^3, with the respiratory system, as a target of the reference exposure level.

It should be emphasized that exceeding the chronic REL does not necessarily indicate that an adverse health impact will occur. However, levels of exposure above the REL have an increasing but undefined probability of resulting in an adverse health impact, particularly in sensitive individuals (e.g., depending on the toxicant, the young, the elderly, pregnant women, and those with acute or chronic illnesses).

The significance of exceeding the REL is dependent on the seriousness of the health endpoint, the strength and interpretation of the health studies, the magnitude of combined safety factors, and other considerations. In addition, there is a possibility that an REL may not be protective of certain small, unusually sensitive human subpopulations. Such subpopulations can be difficult to identify because of their small numbers, lack of knowledge about toxic mechanisms, and other factors. It may be useful to consult OEHHA staff when an REL is exceeded.

The hazard index (HI) is then calculated by taking the annual average diesel PM concentration, and dividing by the chronic REL of 5 μg/m^3. An HI value of 1 or greater indicates an exceedance of the chronic REL, and some adverse health impacts would be expected.

> ***Hazard Index****: The ratio of the potential exposure to the substance and the level at which no adverse effects are expected.*

As part of this study, ARB staff conducted an analysis of the potential non-cancer health impacts associated with exposures to the model-predicted ambient levels of directly emitted diesel PM from on-site sources within the modeling domain. The HI values were calculated, and then plotted as a series of isopleths in Figure V-2. As shown in the figure, the HI values are relatively small in the vicinity areas around the railyard facility, ranging from 0.02 to 0.2. A higher HI value about 0.3 was estimated near the facility fence line between the northeast side of the railyard and the Interstate I-5. According to OEHHA Guidelines (OEHHA, 2003), the non-cancer health risks are less likely to occur because the model-predicted diesel PM concentrations are much lower than the diesel PM chronic Reference Exposure Level (REL).

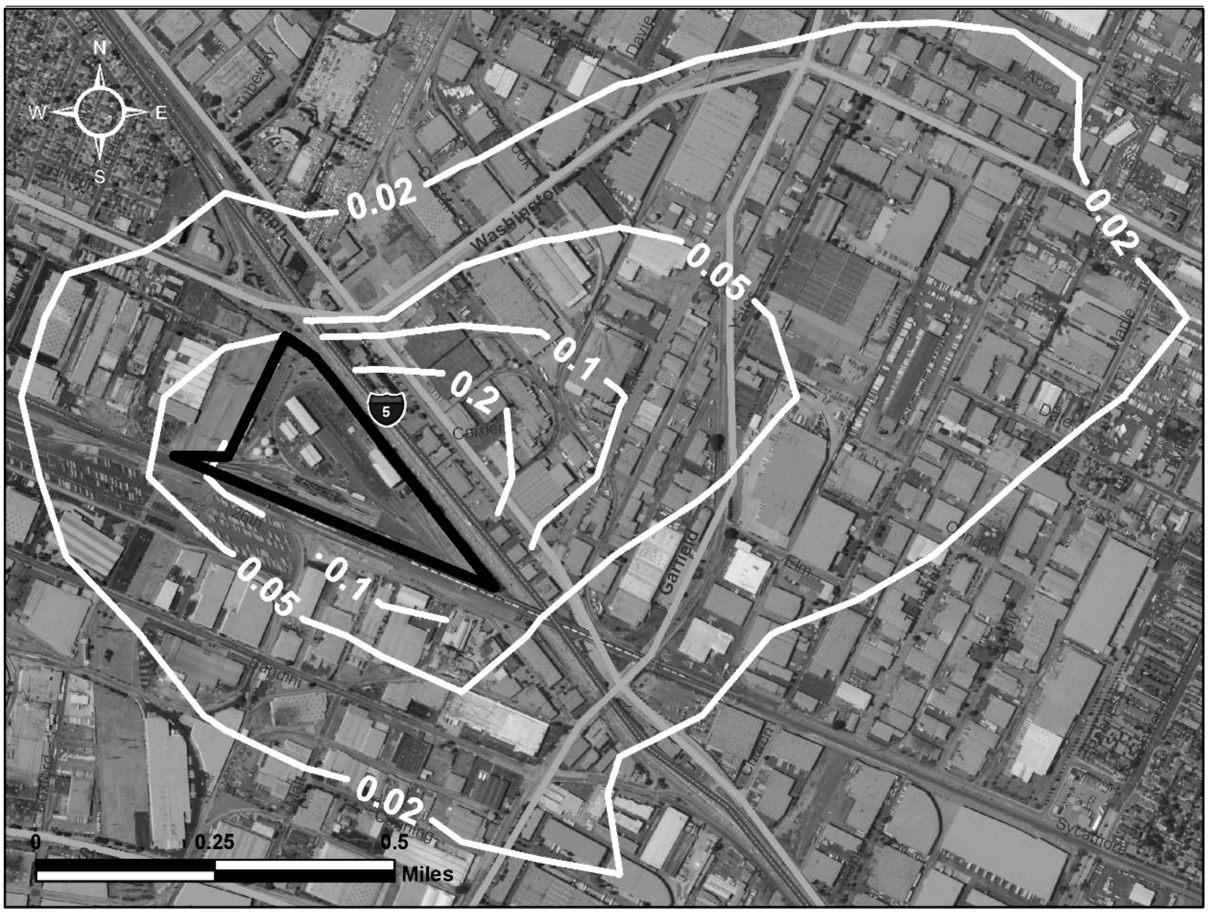


Figure V-2 Estimated potential non-cancer chronic risk isopleths (indicated as Hazard Indices) associated with the on-site diesel PM emissions from the BNSF Sheila Mechanical Railyard.

3. Non-Cancer Acute Risk

According to the OEHHA guidelines, an acute reference exposure level (REL) is an exposure that is not likely to cause adverse health effects in a human population, including sensitive subgroups, exposed to a given concentration for the specified exposure duration (generally one hour) on an intermittent basis. Non-cancer acute risk characterization involves calculating the maximum potential health impacts based on short-term acute exposure and reference exposure levels. Non-cancer acute impacts for the diesel PM are estimated by calculating a hazard index.

Due to the uncertainties in the toxicological and epidemiological studies, diesel PM as a whole was not assigned a short-term acute REL. Only specific compounds of diesel exhaust (e.g., acrolein) have potential acute effects and an assigned acute REL. Acrolein in the air is usually found as a by-product of combustion of fossil fuel. In addition, acrolein has also been largely used as a chemical intermediate in the manufacture of adhesives. It has also been found in other different sources, such as fires, water treatment ponds, and tobacco smoke. However, acrolein is a chemically reactive and unstable compound, and easily reacts with a variety of chemical compounds in the atmosphere. Compared to the other chemical compounds in the diesel exhaust, the concentration of acrolein has a much lower chance of reaching a distant off-site receptor. Given the multitude of activities ongoing at facilities as complex as railyards, there is a much higher level of uncertainty associated with hourly-specific emission data and hourly model-estimated peak concentrations for short-term exposure, which are essential to assess the acute risk. Therefore, non-cancer acute risk is not addressed quantitatively in this study.

E. Risk Characterization Associated with Off-Site Emissions

1. Cancer Risk

ARB staff evaluated the impacts from off-site pollution sources near the BNSF Sheila Mechanical Railyard facility using the U.S. EPA-approved AERMOD dispersion model. Specifically, off-site mobile and stationary diesel PM emission sources located within the two-mile joint off-site boundary of the four Commerce railyards were included (see Figure II-2). Off-site diesel PM emissions used in the off-site modeling runs consisted of about 113.2 tons per year from roadways and 0.2 tons per year from stationary facilities, representing emissions for 2005. The diesel PM emissions from all four Commerce railyards are not analyzed in the off-site air dispersion modeling. The same meteorological data and coarse receptor grid system used for on-site air dispersion modeling was used for the off-site modeling runs. The estimated potential cancer risks from the off-site emissions are presented in Figure V-3.

Based on the 2000 U.S. Census Bureau's data, the zone of impact of the estimated potential cancer risks above 100 cases in a million levels associated with off-site diesel PM emissions encompasses approximately 28,300 acres where about 430,000 residents live. The zone of impacts of estimated cancer risks associated with off-site diesel PM emissions is much larger as compared to that associated with the BNSF Sheila Mechanical Railyard diesel PM emissions. Detailed calculations and the methodology used in off-site air dispersion modeling are presented in Appendix C.

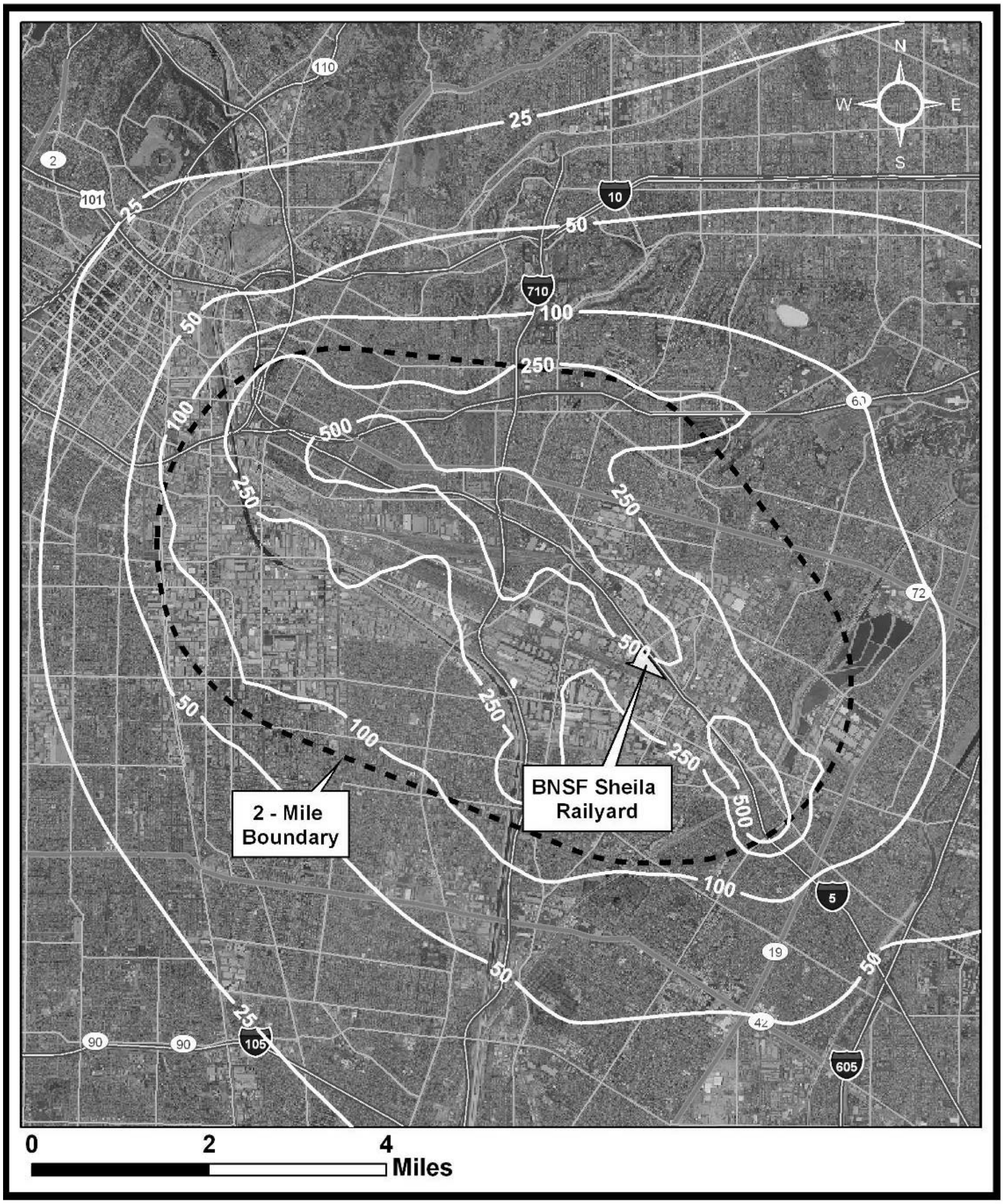


Figure V-3 Estimated potential cancer risk isopleths (chances in a million) associated with off-site stationary and mobile diesel PM emissions within the two-mile joint off-site boundary (shown as dashed line), based on 80th percentile breathing rate and 70-year exposure.

Table V-3 presents the exposed population and area coverage for various impacted zones of cancer risks associated with off-site diesel PM emissions. The impacted area with an estimated potential cancer risk level exceeding 10 chances in a million encompasses about 198,000 acres and about 1.9 million people inhabit according to the 2000 Census data

Table V-3 Estimated impacted areas and exposed population associated with different cancer risk levels associated with off-site diesel PM emissions within the two-mile joint off-site boundary (based on 80th percentile breathing rate for 70-year exposure).

Estimated Potential Cancer Risk (chances per million)	Impacted Area (Acres)	Estimated Population Exposed
10 - 25	126,000*	650,000*
25 - 50	25,420*	529,000*
50 - 100	18,070	303,000
100 - 250	17,350	285,000
250 - 500	8,610	100,000
>500	2,330	45,000

*: Approximate estimates due to the fact that part of the isopleths exceed the modeling domain.

2. Non-Cancer Chronic Risk

The non-cancer chronic risks (indicated as hazard indices) from the off-site diesel PM emissions are presented in Figure V-4. For the residential areas around the railyards, the risk levels are estimated ranging from 0.1 to 0.3. The areas adjacent to Interstate I-5, I-710, and highway CA-60 show higher chronic risks as compared to other regions. Over 62% of off-site mobile diesel PM emissions is linked to these major traffic roadways in the region. The estimated range of hazard indices in the region may suggest that the non-cancer health risks are less likely to occur as compare to a ratio of 1.0.

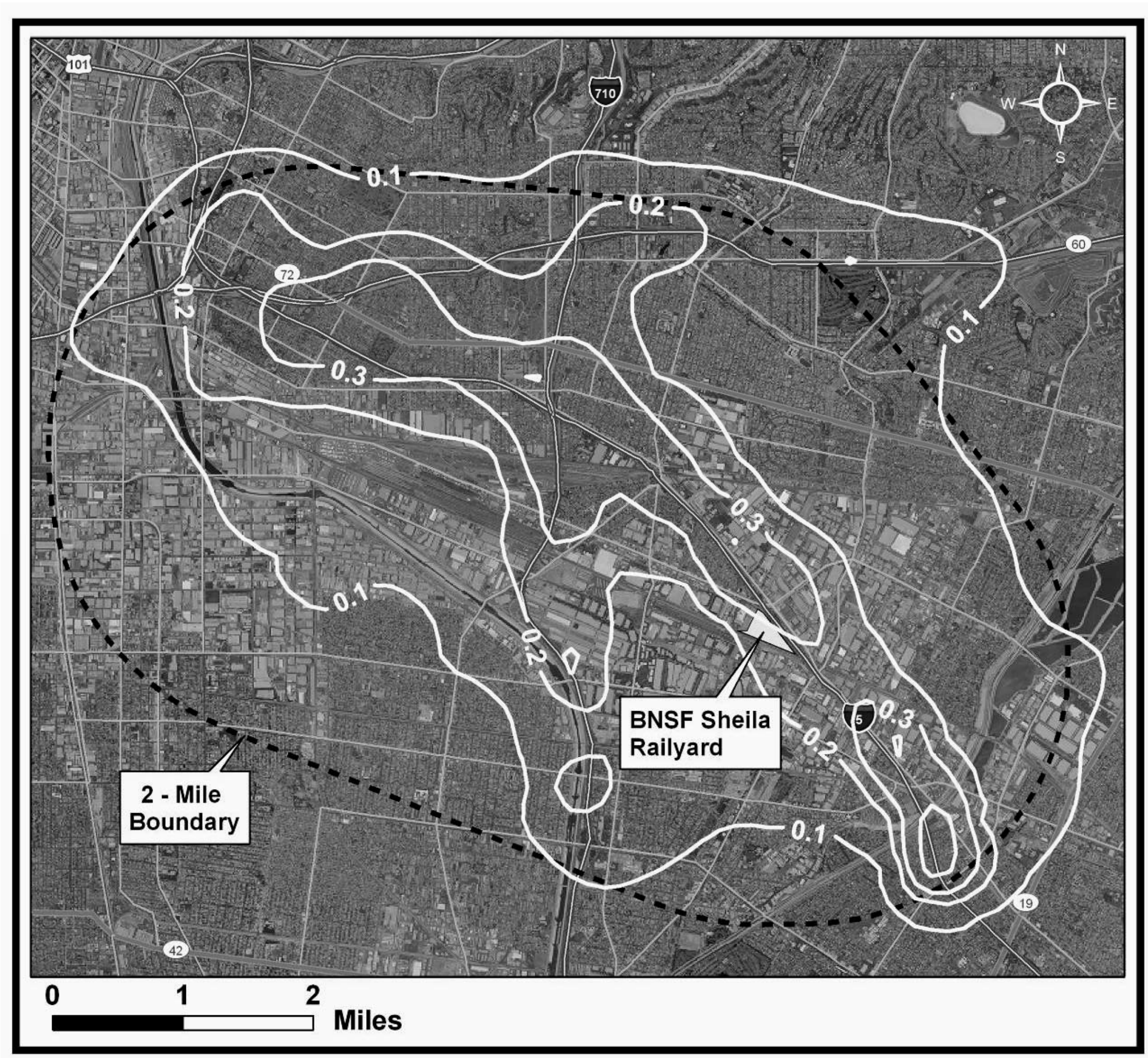


Figure V-4 Estimated non-cancer risks (indicated as hazard indices) associated with off-site diesel PM emissions within the two-mile joint off-site boundary (shown as dashed line).

F. Risks to Sensitive Receptors Surrounding the BNSF Sheila Mechanical Railyard

Some individuals may be more sensitive to toxic exposures than the general population. These sensitive populations may be identified as school-aged children or seniors. There are four sensitive receptors in the neighboring areas (within one-mile from the railyard) around the BNSF Sheila Mechanical Railyard, including two schools and two childcare centers. Table V-4 shows the number of sensitive receptors in various levels of cancer risk associated with diesel PM emissions from the BNSF Sheila Mechanical Railyard based on 70-year residential exposure duration. There are two receptors are located at the impacted zone with a potential cancer risk from 10 to 25 in a million, and one in the zone of 25 to 50 in a million.

Table V-4 The number of sensitive receptors identified in various levels of cancer risks associated with on-site diesel PM emissions (based on 80th percentile breathing rate and 70-year exposure).

Estimated Cancer Risk (chances per million)	Number of Sensitive Receptors
10 – 25	2
25 – 50	1

G. Uncertainty and Limitations

Risk assessment is a complex procedure which requires the integration of many variables and assumptions. The estimated diesel PM concentrations and risk levels produced by a risk assessment are based on several assumptions, many of which are designed to be health protective so that potential risks to individual are not underestimated.

As described previously, the health risk assessment consists of three components: (1) emission inventory, (2) air dispersion modeling, and (3) risk assessment. Each component has a certain degree of uncertainty associated with its estimation and prediction due to the assumptions made. Therefore, there are uncertainties and limitations with the results.

The following subsections describe the specific sources of uncertainties in each component. In combination, these various factors may result in potential uncertainties in the location and magnitude of predicted concentrations, as well as the potential health effects actually associated with a particular level of exposure.

1. Emission Inventory

The emission rate often is considered to be proportional to the type and magnitude of the activity at a source, e.g., the operation. Ideally, emissions from a source can be calculated on the basis of measured concentrations of the pollutant in the sources and emission strengths, e.g., a continuous emission monitor. This approach can be very costly and time consuming and is not often used for the emission estimation. Instead, emissions are usually estimated by the operation activities or fuel consumption and associated emission factors based on source tests.

The uncertainties of emission estimates may be attributed to many factors such as a lack of information for variability of locomotive engine type, throttle setting, level of maintenance, operation time, and emission factor estimates. Quantifying individual uncertainties is a complex process and may in itself introduce unpredictable uncertainties[5].

For locomotive sources at the BNSF Sheila Mechanical Railyard, the activity rates include primarily the number of engines in operation and the time spent in different power settings. The methodology used for the locomotive emissions is based on these facility-specific activity data. The number of engines operating in the facility is generally well-tallied by BNSF's electronic monitoring of locomotives entering and leaving the railyard. However, the monitoring under certain circumstances may produce duplicate readings that can result in overestimates of locomotive activity. In addition to recorded activity data, surveys and communications with facility personnel, and correlations from other existing data, (e.g., from the Roseville Railyard Study (ARB, 2004a)), all were used to verify the emission estimations in the emission inventory.

Uncertainties also exist in estimates of the engine time in mode. Idling is typically the most significant operational mode, but locomotive event recorder data could not distinguish when an engine is on or off during periods when the locomotive is in the idle notch. As a result, a professional judgment is applied to distinguish between these two modes. While the current operations may not be precisely known, control measures

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[5] The railyard HRAs have been performed using a methodology according to the ARB's and OEHHA Guidelines, and consistent with previous health risk analyses conducted by ARB. Similar to any model with estimations, the primary barriers of an HRA to determine objective probabilities are lack of adequate scientific understanding and more precise levels of data. Subjective probabilities are also not always available.

Tier-1 methodology is a conservative point approach but suitable for the current HRA's scope, given the condition and lack of probability data. Tier-1 approach used in the HRAs is consistent with previous health risk analyses performed by ARB, "The Roseville Railyard Study (ARB, 2004)" and "Diesel PM Exposure Assessment Study for the Ports of Los Angeles and Long Beach (ARB, 2006d)". By recognizing associated uncertainties or variability, the HRAs have qualitatively discussed the limitation and caveats of possible underestimation and overestimation in emission inventory and modeling predictions because of assumptions and simplifications. The discussion provides an additional reference for HRA results even though quantitative uncertainty bounds are unavailable. Most importantly, it is not practical to characterize and quantify the uncertainty of estimated health risks without the support of robust scientific data and actual probability distribution functions of model variables. An attempt to incorporate subjective judgments on uncertainty analyses can lead to misinterpretation of HRA findings.

already being implemented are expected to result in reduced activity levels and lower emissions than are estimated here for future years.

As discussed previously, emission factors are often used for emission estimates according to different operating cycles. The Roseville Railyard Study (ARB, 2004) developed representative diesel PM emission factors for locomotives in different duty cycles. To reduce the possible variability of locomotive population and the uncertainty from assumptions, the emission factors were updated in the study to cover a wide range of locomotive fleet in the State (see Appendix D). The fuel usage in the locomotives in 2005 was calculated from the BNSF's annual fuel consumption database. These critical updates for locomotive emission inventory have established the most representative locomotive emission factors for the study.

For non-locomotive emissions, uncertainty associated with vehicles and equipment at the railyard facility also exists because the duty cycles (i.e., engine load demanded) are less well characterized. Default estimates of the duty cycle parameters may not accurately reflect the typical duty demanded from these vehicles and equipment at any particular site. In addition, national and state regulations have targeted these sources for emission reductions. Implementation of these rules and fleet turnover to newer engines meeting more strict standards should significantly reduce emissions at these rail sites in future years. However, the effects of these regulations have not been incorporated in the emission estimates, so estimated emissions are greater than those expected for future years at the same activity level.

2. Air Dispersion Modeling

An air dispersion model is derived from atmospheric diffusion theory with assumptions or, alternatively, by solution of the atmospheric-diffusion equation assuming simplified forms of effective diffusivity. Within the limits of the simplifications involved in its derivation, the model-associated uncertainties are vulnerably propagated into its downstream applications.

Model uncertainty may stem from data gaps that are filled by the use of assumptions. Uncertainty is often considered as a measure of the incompleteness of one's knowledge or information about a variate whose true value could be established if a perfect measurement is available. The structure of mathematical models employed to represent scenarios and phenomena of interest is often a key source of model uncertainty, due to the fact that models are often only a simplified representation of a real-world system, such as the limitation of model formulation, the parameterization of complex processes, and the approximation of numerical calculations. These uncertainties are inherent and exclusively caused by the model's inability to represent a complex aerodynamic process. An air dispersion model usually uses simplified atmospheric conditions to simulate pollutant transport in the air, and these conditions become inputs to the models (e.g., the use of non site-specific meteorological data, uniform wind speed over the simulating domain, use of surface parameters for the meteorological station as opposed to the railyard, substitution of missing meteorological data, and simplified emission source representation). There are also other physical dynamics in the transport process, such as the small-scale turbulent flow in the air, which are not characterized by the air dispersion models. As a result of the simplified representation of real-world physics, deviations in pollutant concentrations predicted by the models may occur due to the introduced uncertainty sources.

The other type of uncertainty is referred as reducible uncertainty, a result of uncertainties associated with input parameters of the known conditions, which include source characteristics and meteorological inputs. However, the uncertainties in air dispersion models have been improved over the years because of better representations in the model structure. In 2006, the U.S. EPA modeling guidance was updated to replace the Industrial Source Complex model with AERMOD as a recommended regulatory air dispersion model for determining single source and source complex. Many updated formulations have been incorporated into the model structure from its predecessor, ISCST3, for better predictions from the air dispersion process. Nevertheless, quantifying overall uncertainty of model predictions is infeasible due to the associated uncertainties described above, and is beyond the scope of this study.

3. Risk Assessment

The toxicity of toxic air contaminants is often established by available epidemiological studies, or use of data from animal studies where data from humans are not available. The diesel PM cancer potency factor is based on long term studies of railyard workers exposed to diesel exhaust in concentration approximately ten times typical ambient exposures The differences within human populations usually cannot be easily quantified and incorporated into risk assessments. Factors including metabolism, target site sensitivity, diet, immunological responses, and genetics may influence the response to toxicants. In addition, the human population is much more diverse both genetically and culturally (e.g., lifestyle, diet) than inbred experimental animals. The variability among humans is expected to be much greater than in laboratory animals. Adjustment for tumors at multiple sites induced by some carcinogens could result in a higher potency. Other uncertainties arise (1) in the assumptions underlying the dose-response model used, and (2) in extrapolating from large experimental doses, where, for example, other toxic effects may compromise the assessment of carcinogenic potential due to much smaller environmental doses. Also, only single tumor sites induced by a substance are usually considered. When epidemiological data are used to generate a carcinogenic potency, less uncertainty is involved in the extrapolation from workplace exposures to environmental exposures. However, children, a subpopulation whose hematological, nervous, endocrine, and immune systems are still developing and who may be more sensitive to the effects of carcinogens on their developing systems, are not included in the worker population and risk estimates based on occupational epidemiological data are more uncertain for children than adults.

Human exposures to diesel PM are often based on limited availability of data and are mostly derived based on estimates of emissions and duration of exposure. Different epidemiological studies also suggest somewhat different levels of risk. When the Scientific Review Panel (SRP) identified diesel PM as a toxic air contaminant (ARB, 1998), the panel members endorsed a range of inhalation cancer potency factors (1.3 x 10^{-4} to 2.4 x 10^{-3} $(\mu g/m^3)^{-1}$) and a risk factor of $3x10^{-4}$ $(\mu g/m^3)^{-1}$, as a reasonable estimate of the unit risk. From the unit risk factor an inhalation cancer potency factor of 1.1 $(mg/kg\text{-}day)^{-1}$ can be calculated, which is used in the study. There are many epidemiological studies that support the finding that diesel exhaust exposure elevates relative risk for lung cancer. However, the quantification of each uncertainty applied in the estimate of cancer potency is very difficult and can be itself uncertain.

This study adopts the standard Tier 1 approach recommended by the OEHHA for exposure and risk assessment. A Tier 1 approach is an end-point estimate methodology without the consideration of site-specific data distributions. It also assumes that an individual is exposed to an annual average concentration of a pollutant continuously for individual is exposed to a specific time period. The OEHHA recommends the lifetime 70-year exposure duration with a 24-hour per day exposure be used for determining residential cancer risks. This will ensure a person residing in the vicinity of a facility for a lifetime will be included in the evaluation of risk posed by the facility. Lifetime 70-year exposure is a conservative estimate, but it is a historical benchmark for comparing facility impacts on receptors and for evaluating the effectiveness of air pollution control measures. Although it is not likely that most people will reside at a single residence for 70 years, it is common that people will spend their entire lives in a major urban area. While residing in urban areas, it is very possible to be exposed to the emissions of another facility at the next residence. In order to help ensure that people do not accumulate an excess unacceptable cancer risk from cumulative exposure to stationary facilities at multiple residences, the 70-year exposure duration is used for risk management decisions. However, if a facility is notifying the public regarding health risk, it is a useful indication for a person who has resided in his or her current residence less than 70 years to know that the calculated estimate of his or her cancer risk is less than that calculated for a 70-year risk (OEHHA, 2003). Risk assessment is best viewed as a comparative tool rather than a literal prediction of diesel incidence in a community.

Since the Tier-1 methodology is used in the study for the health risk assessment, the results have been limited to deterministic estimates based on conservative inputs. For example, an 80 percentile breathing rate approach is used to represent a 70-year lifetime inhalation that tends toward the high end for the general population. Moreover, the results based on the Tier-1 estimates do not provide an indication of the magnitude of uncertainty surrounding the quantities estimated, nor an insight into the key sources of underlying uncertainty.

REFERENCES

ARB, 1998. Proposed Identification of Diesel Exhaust as a Toxic Air Contaminant, Staff Report, April, 1998

ARB, 2000. Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles, Staff Report, October, 2000.

ARB, 2002. Public Hearing to Consider Amendments to the Ambient Air Quality Standards for Particulate Matter and Sulfates, Staff Report, May. 2002.

ARB, 2004a. Roseville Railyard Study, October, 2004.

ARB, 2004b. ARB Recommended Interim Risk Management Policy for Inhalation-Based Residential Cancer Risk, March, 2004. (http://www.arb.ca.gov/toxics/harp/rmpolicyfaq.htm)

ARB, 2005. ARB/Railroad Statewide Agreement Particulate Emissions Reduction Program at the California Rail Yards. Sacramento, CA. June, 2005.

ARB, 2006a. Emission Reduction Plan for Ports and Goods Movement in California, March, 2006.

ARB, 2006b. ARB Health Risk Assessment Guidance for Railyard and Intermodal Facilities. July, 2006.

ARB, 2006c. The California Almanac of Emissions and Air Quality, 2006 Edition.

ARB, 2006d. Diesel Particulate Matter Exposure Assessment Study for the Ports of Los Angeles and Long Beach, Final Report. April, 2006.

ARB, 2006e. ARB Railyard Emissions Inventory Methodology. July, 2006.

ENVIRON, 2006a. BNSF Sheila Mechanical Railyard Toxic Air Contaminant Emission Inventory. Emeryville, CA. November, 2006.

ENVIRON, 2006b. Air Dispersion Modeling Assessment of Air Toxic Emissions from BNSF Sheila Mechanical Railyard, Report No. 06-12910J5B. Emeryville, CA. November, 2006.

Krewski, D., Burnett, R.T., Goldberg, M.S., Hoover, K., Siemiatycki, J., Jarret, M., Abrahamowicz, M., White, W.H., Reanalysis of the Harvard Six Cities Study and the

American Cancer Society Study of Particulate Air Pollution and Mortality, Special Report, Health Effects Institute, Cambridge, MA, 2000.

Lloyd, A.C., Cackett, T.A., Critical Review, Diesel Engines: Environmental Impact and Control, *J. Air & Waste Manage. Assoc.*, 2001, 51, 809-847.

OEHHA, 2000. Air Toxics Hot Spot Program Risk Assessment Guidelines: Part IV- Technical Support Document for Exposure Analysis and Stochastic Analysis. Office of Environmental Health Hazard Assessment. September, 2000.

OEHHA, 2002. Air Toxics Hot Spot Program Risk Assessment Guidelines: Part II- Technical Support Document for Describing Available Cancer Potency Factors. Office of Environmental Health Hazard Assessment. December, 2002.

OEHHA, 2003. Air Toxics Hot Spots Program Risk Assessment Guidelines: The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. Office of Environmental Health Hazard Assessment. August, 2003.

Pope, C.A, III; Thun, M.J.; Namboodiri, M.M.; Dockery, D.W.; Evans, J.S.; Speizer, F.E.; Heath, J.C.W. Particulate Air Pollution as a Predictor of Mortality in a Prospective Study of U.S. Adults, *Am. J. Respir. Crit. Care. Med.*, 1995, 151, 669-674.

Pope, C.A, III; Burnett, R.T., Thun, M.J.; Calle, E.E. Krewski, D., Ito, K., Thurston, G.D. Lung Cancer, Cardiopulmonary Mortality, and Long-Term Exposure to Fine Particulate Air Pollution, *J. Am. Med. Assoc*., 2002, 287, 1132-1141.

Pope, C.A.; III; Burnett, R.T.; Thurston, G.D.; Thun, M.J.; Calle, E.E.; Krewski, D.; Godleski, J.J. Cardiovascular Mortality and Long-Term Exposure to Particulate Air Pollution: Epidemiological Evidence of General Pathophysiological Pathways of Disease; *Circulation,* 2004, *109,* 71-77.

SCAQMD, 2000. Multiple Air Toxics Exposure Study in the South Coast Air Basin (MATES-II), Final Report, March, 2000.

U.S. EPA, 1985. Guideline for Determination of Good Engineering Practice Stack Height (Technical Support Document for the Stack Height Regulations) – Revised. EPA-450/4-80-023R, Office of Air Quality Planning and Standards, U.S. EPA, Research Triangle Park, NC. June, 1985.

U.S. EPA, 2004a. User's Guide for the AMS/EPA Regulatory Model – AERMOD. Report No. EPA-454/B-03-001. Office of Air Quality Planning and Standards. Emissions Monitoring and Analysis Division, Research Triangle Park, NC. September, 2004.

U.S. EPA, 2004b. User's Guide for the AERMOD Meteorological Preprocessor. Report No. EPA-454/B-03-002. Office of Air Quality Planning and Standards. Emissions Monitoring and Analysis Division, Research Triangle Park, NC. September, 2004.

U.S. EPA, 2005. Federal Register, Part III, 40 CFR part 51, Vol. 70, No. 216, November 9, 2005.

APPENDIX A

METHODOLOGY OF OFF-SITE MOBILE SOURCE EMISSIONS

INTRODUCTION

This assessment includes on-road mobile emissions from all heavy duty diesel truck running exhaust as it is the primary source of diesel particulate emissions within the on-road vehicle fleet. Traditionally, on-road mobile emission inventories are generated at the county scale using California's emission factor model EMFAC and then allocated to large grid cells using the Direct Travel Impact Model (DTIM). To enhance the spatial resolution we have estimated emissions based on roadway specific vehicle activity data and allocated them to individual roadway links. All roadway links within a 2-mile buffer of the combined Commerce yards and all links within a 1-mile buffer of all other yards were included in this assessment. This inventory does not include emissions generated by idling of heavy duty trucks or any off-road equipment outside the rail yards.

As more and more work has been done to understand transportation modeling and forecasting, access to local scale vehicle activity data has increased. For example, the various Metropolitan Planning Organizations (MPOs) are mandated by the Federal government to maintain a regional transportation plan and regional transportation improvement plan. These reports assess the impact the travel growth and assess various transportation improvement plans[6]. Planning is based on travel activity results from Transportation Demand Models (TDMs) that forecast traffic volumes and other characteristics of the transportation system. Currently, more than a dozen MPOs as well as the California Department of Transportation (Caltrans) maintain transportation demand models. Through a system of mathematical equations TDMs estimate vehicle population and activity estimates such as speed and vehicle miles traveled (VMT) based on data about population, employment, surveys, income, roadway and transit networks and transportation costs. The activity is then assigned a spatial and temporal distribution by allocating them to roadway links and time periods. A roadway link is defined as a discrete section of roadway with unique estimates for the fleet specific population and average speed and is classified as a freeway, ramp, major arterial, minor arterial, collector, or centroid connector. Link based emission inventory development utilizes these enhanced spatial data and fleet and pollutant specific emission factors to estimate emissions at the neighborhood scale.

METHODOLOGY

Estimating emissions from on-road mobile sources outside the rail yards was broken into four main processes and described below. The first step involves gathering vehicle activity data specific to each link on the roadway network. Each link contains 24 hours worth of activity data including vehicle miles traveled, vehicle type, and speed. The activity is then apportioned to the various heavy duty diesel truck types (Table A-1) where speed-specific VMT is then matched to an emission factor from EMFAC to

[6] SCAG Transportation Modeling, http://www.scag.ca.gov/modeling/ (Accessed January 2007).

estimate total emissions from each vehicle type for each hour of the day. The working draft of EMFAC, rather than EMFAC2007, was used for this assessment because at the time this project was underway EMFAC2007 was not completed. The working draft of EMFAC, however, contains nearly all the revisions in EMFAC2007 that would affect these calculations.

Table A-1: Heavy duty truck categories

Class	Description	Weight (GVW)	Abbreviation	Technology Group
T4	Light-Heavy Duty Diesel Trucks	8,501-10,000	LHDDT1	DIESEL
T5	Light-Heavy Duty Diesel Trucks	10,001-14,000	LHDDT2	DIESEL
T6	Medium-Heavy Duty Diesel Trucks	14,001-33,000	MHDDT	DIESEL
T7	Heavy-Heavy Duty Diesel Trucks	33,001+	HHDDT	DIESEL

Step 1: Obtain Link-Specific Activity Data[7]

The link specific activity data for heavy duty trucks necessary to estimate emissions are speed and vehicle miles traveled (VMT), where VMT is a product of vehicle volume (population) and link length. Link activity for Ventura, Los Angeles, Orange, and more than 90% of Riverside and San Bernardino counties are provided by the Southern California Association of Governments (SCAG) Heavy Duty Truck Transportation Demand Model. Heavy duty truck activity is modeled using truck specific data, commodity flows and goods movement data. SCAG, however, is the only MPO with a heavy duty truck model. The remaining counties under the railyard study are covered by the Integrated Transportation Network (ITN) developed by Alpine Geophysics[‡]. The Integrated Transportation Network was developed by stitching together MPO transportation networks and the Caltrans statewide transportation network. Link specific truck activity from the ITN is estimated as a fraction of the total traffic on the links and is based on the fraction of trucks within each county as it is estimated in EMFAC.

[‡] Wilkinson, James (Alpine Geophysics); et al. “Development of the California Integrated Transportation Network (ITN),” Alpine Geophysics – Atmospheric and Hydrologic Sciences, La Honda, CA (2004). http://www.arb.ca.gov/airways/CCOS/docs/III3_0402_Jun06_fr.pdf

The product of truck volume and link length is referred to as vehicle miles traveled (VMT) and has units of miles. Transportation demand models provide total VMT for each link without further classification into the various heavy duty truck weight and fuel type classifications. Therefore, in order to assess the emissions only from heavy duty diesel trucks the total heavy duty truck VMT is multiplied by the fraction of trucks that are diesel. Once the total diesel VMT is calculated the heavy duty truck diesel VMT is multiplied by the fraction of trucks that make up the four weight classifications. The fuel and weight fractions are specific to each county and are derived from total VMT for each weight and fuel class in EMFAC for each county. The data is then compiled into an activity matrix (Table A-2) composed of a link identification code, hour of the day, speed, light heavy duty diesel 1 truck (LHDDT1) VMT, light heavy duty diesel 2 truck (LHDDT2) VMT, medium heavy duty diesel truck (MHDDT) VMT, and heavy heavy duty diesel truck (HHDDT) VMT.

Table A-2 Activity matrix example

LINKID	Hour	Speed (mph)	LHDDT1 VMT (miles)	LHDDT2 VMT (miles)	MHDDT VMT (miles)	HHDDT VMT (miles)
49761	12	45	0.37	0.48	3.17	5.51
49761	3	45	0.14	0.18	1.16	2.00
49761	3	35	0.16	0.21	1.37	2.38
50234	4	55	0.19	0.26	1.68	2.92

Step 2: Derive Gram per Mile Emission Factors

The second step of the emission inventory process involves developing emission factors for all source categories for a specified time period, emission type, and pollutant. Running exhaust emission factors based on vehicle type, fuel type and speed were developed from the Emfac mode of EMFAC. These are composite emission factors based on the model year distribution for each county and provided in units of grams of emissions per mile traveled. Finally, a matrix of emission factors by speed and vehicle type was assembled for each county for light heavy-duty diesel trucks 1 and 2 (LHDDT1 and LHDDT2), medium heavy-duty diesel trucks (MHDDT) and heavy heavy-duty diesel trucks (HHDDT). The following is an example of such a matrix (Table A-3):

Table A-3 Emission factor matrix example.

Speed (mph)	Diesel PM Emission Factors (g/mile)			
	LHD1 DSL	LHD2 DSL	MHD DSL	HHD DSL
12	0.101	0.145	0.631	2.371
20	0.072	0.105	0.455	1.277
45	0.037	0.054	0.235	0.728
60	0.033	0.047	0.206	1.095

Step 3: Calculate Emissions

Diesel particulate matter (DPM) emission factors are provided as grams per mile specific to each speed and heavy duty truck type (see table above). To estimate emissions the activity for each diesel heavy duty truck type was matched to the corresponding emission factor (EF). For example, a 0.25 mile long link at 3 am in the morning has 8 heavy heavy-duty diesel trucks (HHDDTs) traveling at 45 miles per hour. This equates to a VMT of 2.00 miles (8 trucks*0.25 miles). EMFAC has provided a gram per mile emission factor for HHDDT traveling at 45 mph in Los Angeles County as 0.728 grams DPM/mile. In order to estimate total emissions from HHDDTs on that link during that hour of the day the following calculation is made:

$$TotalEmissions(grams) = EF \cdot (Volume \cdot LinkLength) = EF \cdot VMT$$

$$TotalEmissions(grams) = EF \cdot VMT = 0.728 \frac{grams}{mile} \cdot 2.00 miles = 1.45 grams$$

The steps outlined above and in Steps 1 and 2 can be represented with this single equation that provides an emissions total for each link for each hour of the day.

$$Emissions = VMT_{link} \cdot \sum_{i,j} Fraction_{i,j} \cdot EF_{i,j}$$

where

- Emissions – the total emissions in grams for each link
- i = represents the individual diesel heavy duty truck types (LHDDT1, LHDDT2 – light heavy duty diesel trucks 1 and 2; MHDDT – medium heavy duty diesel truck; and HHDDT – heavy heavy duty diesel truck)
- j – represent the hours of the day (hours 1-24)
- VMT_{Link} - total VMT for that link for all heavy duty trucks (gasoline and diesel)

- Fraction = the fraction of the VMT that is attributable to each diesel heavy duty truck type The fraction is estimated based on VMT estimates in EMFAC: Example: $VMT_{MHDDT}/VMT_{\text{all heavy duty trucks (gasoline \& diesel)}}$
- EF = the heavy duty diesel truck emission factors. The emission factor is vehicle type and speed specific and is thus matched according to the link specific activity parameters.

From this expression diesel particulate matter emissions are provided for each link and for each hour of the day. Finally, emissions are summed for all links for all hours of the day to provide a total daily emission inventory.

Step 4: QA/QC – Quality Assurance/Quality Control

To assure that the total emissions were calculated correctly the total emissions (grams) were divided by the total diesel VMT to estimate a composite diesel gram per mile emission factor. This back-calculated emission factor was checked against emission factors in EMFAC. In addition, where possible, heavy duty truck gate counts provided for the rail yards were checked against traffic volumes on the links residing by the gates.

LIMITATIONS AND CAVEATS

We have made several important assumptions in developing this inventory. While these assumptions are correct at the county level they may be incorrect for the particular areas modeled in this assessment. For example, the county specific default model year distribution within EMFAC, and vehicle type VMT fractions were assumed to be applicable for all links within the domain modeled. While this may be accurate at a county level it may not reflect link specific model year distributions or vehicle makeup. Furthermore, these data and activity information used are several years old and may not reflect the latest data available from the MPOs.

Travel demand model results are checked by comparing actual traffic counts on links where the majority of vehicle travel takes place. Therefore, there will be greater uncertainty associated with activity from minor arterials, collectors, and centroid connectors than from higher volume freeways. Data based strictly on actual traffic counts for each street would provide better activity estimates, but unfortunately very little data is available for such an analysis. Furthermore, while links representing freeways are accurately allocated spatially, the allocation of neighborhood streets and other minor roads are not as well represented.

The emissions inventory developed for this study only included diesel particulate matter emissions from running exhaust as it is the primary diesel source from on-road mobile sources. Emissions from other modes such as idling, starts, tire and break wear were excluded.

APPENDIX B

METHODOLOGY OF OFF-SITE STATIONARY SOURCE EMISSIONS

Emissions from off-site stationary source facilities were identified using the California Emission Inventory Development and Reporting System (CEIDARS) database, which contains information reported by the local air districts for stationary sources within their jurisdiction.

Geographic information system (GIS) mapping tools were used to create a two-mile buffer zone outside the property boundary footprint reported for each railyard. The CEIDARS facilities whose latitude/longitude coordinates fell within the two-mile buffer zone were selected. Because of the close proximity of railyards in the Commerce area, the four railyards (Commerce-BNSF, Commerce-UP-Main, Commerce-UP-Eastern, and Commerce-UP-Mechanical/Sheila) were enclosed in a combined polygon outline, and a two-mile buffer zone was then used around the combined polygon footprint.

The reported criteria pollutants in CEIDARS include carbon monoxide, nitrogen oxides, sulfur oxides, total organic gases, and particulate matter (PM). The reported toxic pollutants include the substances and facilities covered by the Air Toxics “Hot Spots” (AB 2588) program. Diesel exhaust particulate matter (diesel PM) was estimated from stationary internal combustion (IC) engines burning diesel fuel, operating at stationary sources reported in CEIDARS. Diesel PM emissions were derived from the reported criteria pollutant PM that is ten microns or less in diameter (criteria pollutant PM10) emitted from these engines. In a few cases, diesel exhaust PM was reported explicitly under the “Hot Spots” reporting provisions as a toxic pollutant, but generally the criteria pollutant PM10 reported at diesel IC engines was more comprehensive than the toxics inventory, and was therefore the primary source of data regarding diesel PM emissions.

The CEIDARS emissions represent annual average emission totals from routine operations at stationary sources. For the current analysis, the annual emissions were converted to grams per second, as required for modeling inputs for cancer and chronic non-cancer risk evaluation, by assuming uniform temporal operation during the year. (The available, reported emission data for acute, maximum hourly operations were insufficient to support estimation of acute, maximum hour exposures).

The CEIDARS 2004 database year was used to provide the most recent data available for stationary sources. Data for emissions, location coordinates, and stack/release characteristics were taken from data reported by the local air districts in the 2004 CEIDARS database wherever available. However, because microscale modeling requires extensive information at the detailed device and stack level that has not been routinely reported, historically, by many air districts, much of the stack/release information is not in CEIDARS. Gaps in the reported data were addressed in the following ways. Where latitude/longitude coordinates were not reported for the stack/release locations, prior year databases were first searched for valid coordinates, which provided some additional data. If no other data were available, then the coordinates reported for the overall facility were applied to the stack locations. Where parameters were not complete for the stack/release characteristics (i.e., height, diameter, gas temperature and velocity), prior year databases were first searched for valid data. If no reported parameters were available, then U.S. EPA stack defaults from the Emissions Modeling System for Hazardous Air Pollutants (EMS-HAP) program were assigned. The U.S. EPA stack defaults are assigned based on the Source Classification Code (SCC) or Standard Industrial Classification (SIC) code of the operation. If an applicable U.S. EPA default was not available, then a final generic default was applied. To ensure that the microscale modeling results would be health-protective, the generic release parameters assumed relatively low height and buoyancy. Two generic defaults were used. First, if the emitting process was identifiable as a vent or other fugitive-type release, the default parameters assigned were a height of five feet, diameter of two feet, temperature of 100 degrees Fahrenheit, and velocity of 25 feet per second. For all remaining unspecified and unassigned releases, the final generic default parameters assigned were a height of twenty feet, diameter of two feet, temperature of 100 degrees Fahrenheit, and velocity of 25 feet per second. All English units used in the CEIDARS database were converted to metric units for use in the microscale modeling input files.

APPENDIX C

SUMMARY OF AIR DISPERSION MODELING FROM OFF-SITE DIESEL PM EMISSIONS

Impacts from off-site pollution sources near the Commerce railyard facilities were modeled using the U.S. EPA-approved AERMOD dispersion model. Specifically, off-site mobile and stationary diesel PM emission sources located out to a distance of two miles from the perimeter of the BNSF Sheila Mechanical Railyard were included. Other emission sources that were located immediately beyond the two mile zone from the facility, such as a high-volume freeway, have the potential to impact receptors in the modeling grid, but were not considered.

To facilitate modeling of these off-site emission sources, the information summarized in Table C-1 was provided by external sources.

Table C-1 Data Provided by Others for Off-Site Emission Source Modeling.

Type of Data	Description	Data Source
Emission Estimates	Off-site DPM emissions for 2005 Mobile Sources: 113.2 TPY DPM Stationary Sources: 0.2 TPY DPM	PTSD/MSAB
Receptor Grid	41x41 Cartesian grid covering 400 km^2 with uniform spacing of 500 meters. Grid origin: (380400, 3753500) in UTM Zone 11.	Environ
Meteorological Data	AERMET-Processed data for 2005 *Surface*: Lynwood and LA/USC *Upper Air*: San Diego Miramar	Environ
Surface Data	Albedo: 0.15 to 0.19 Bowen Ratio: 0.52 to 4.71 Surface Roughness: 0.87 to 0.97	Environ

The spatial and temporal emissions provided for these sources were converted into the appropriate AERMOD ready files. The off-site emissions were modeled using the same coarse receptor grid and meteorological data used by the consultants for their rail yard model runs, as indicated in the table above.

Figure C-1 Region surrounding the Commerce railyard facilities with the modeling domain indicated by the black outline.

Figure C-1 illustrates the modeling domain and region surrounding the city of Commerce. The domain has dimensions 20 km x 20 km and contains a grid of 1681 receptors with a 500 meter uniform grid spacing.

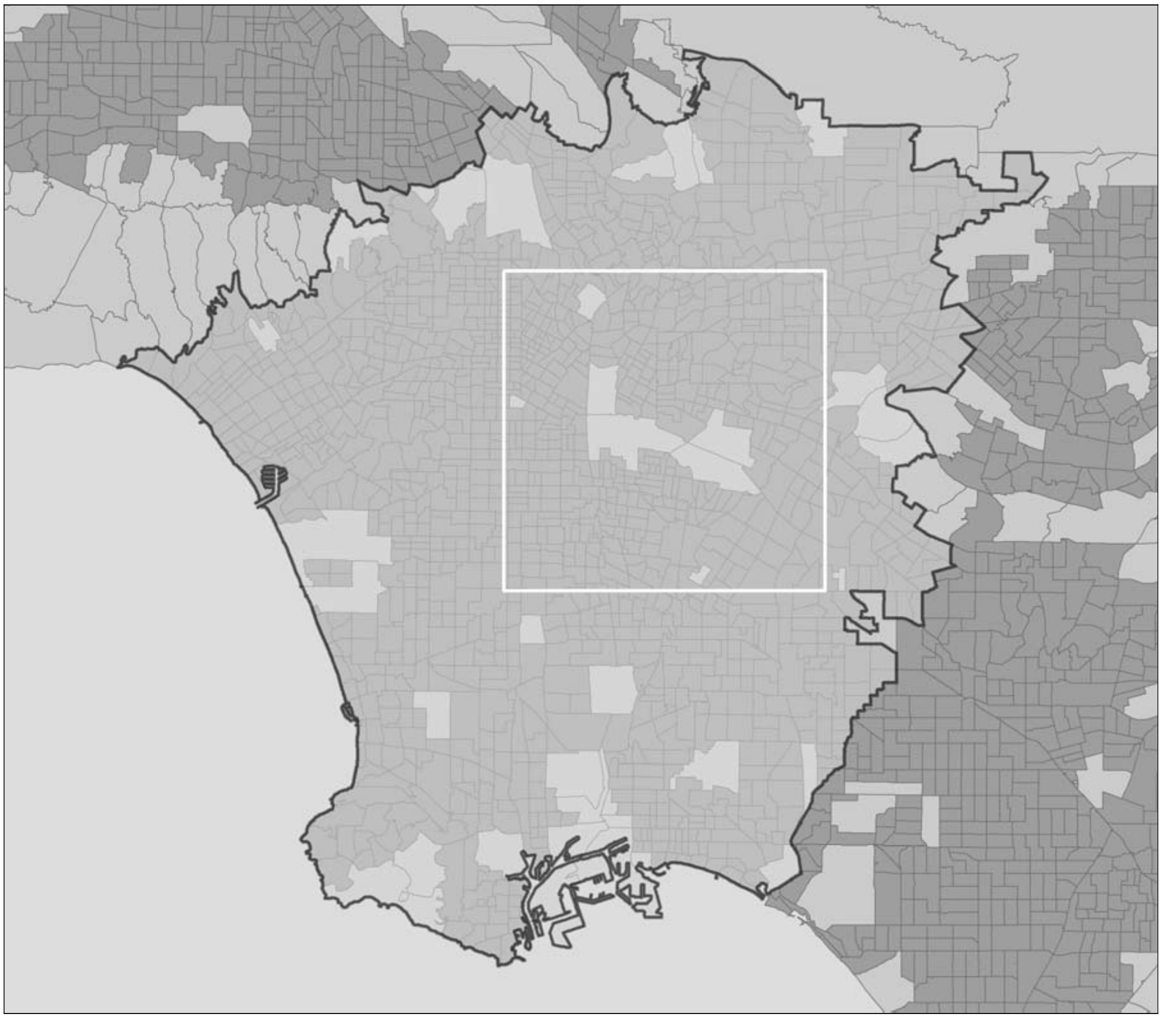

Figure C-2 Urban Population of city of Commerce: Orange denotes areas with at least 750 people/km^2. The highlighted region is the contiguous urban area used for modeling purposes.

AERMOD requires an estimate of the urban population for urban source modeling. The urban population parameter was determined by estimating the area of continuous urban features as defined by the model guidelines (AERMOD Implementation Guide September 27, 2005). According to the guidelines, areas with a population of at least 750 people per square kilometer are considered urban. The model domain is in a region with considerable urbanization. The continuous urban area selected can be seen in Figure C-2. The population in this selected area is 6,476,185.

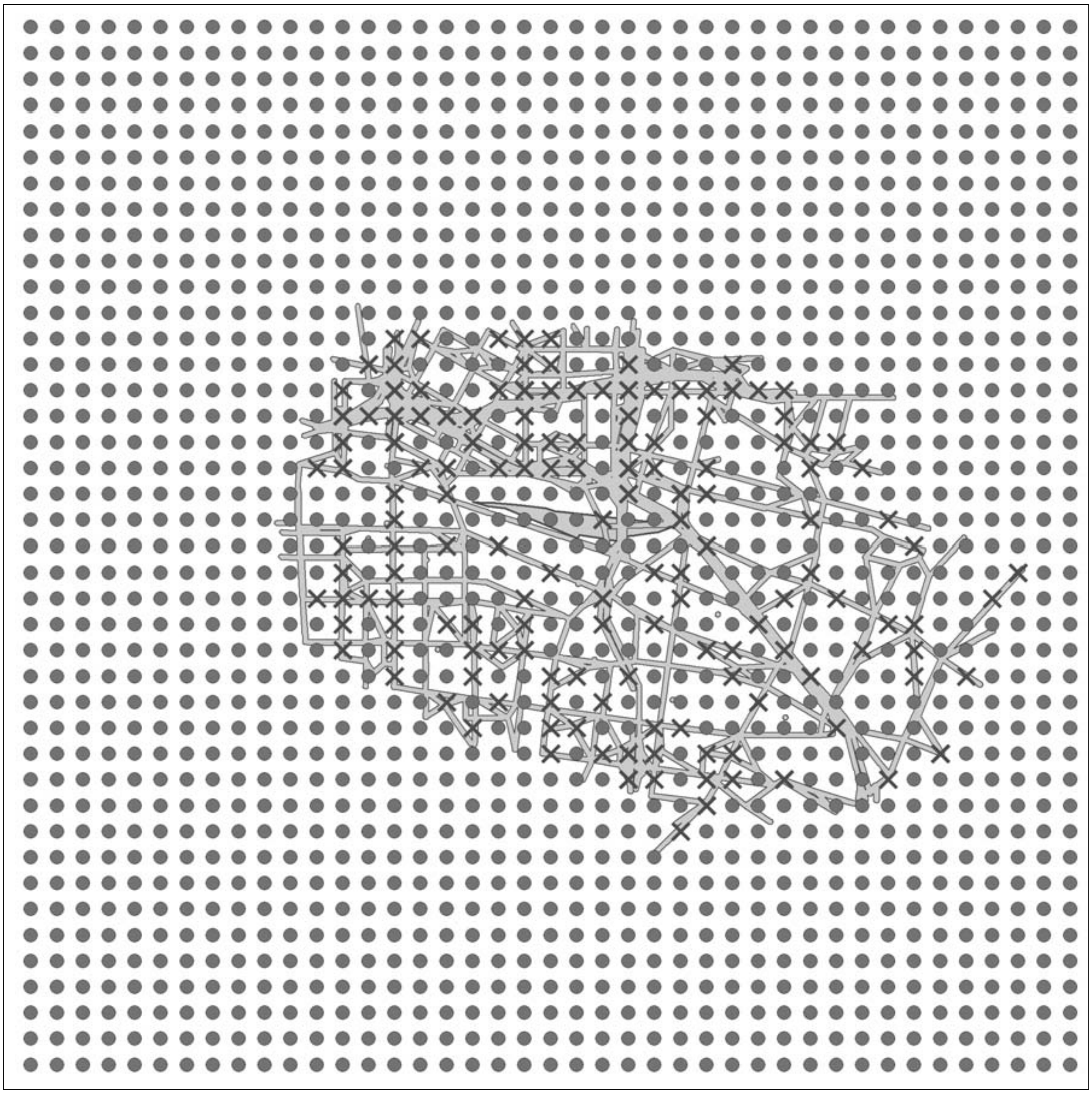

Figure C-3 The modeling receptor network and off-site diesel PM sources within the two-mile joint off-site boundary

The off-site stationary and on-road emission sources used in the model runs are plotted along with the receptor network in Figure C-3. These sources do not represent all stationary and roadway sources within the domain, but rather a subset made up of those roadways and facilities within two miles of the perimeter of the railyard facilities. Diesel PM off-site emissions used in the off-site modeling runs consisted of 113.2 tons per year from roadways and 0.2 tons per year from stationary facilities, representing emissions for 2005. Roadway emissions were simulated as AERMOD area sources with an aspect ratio of no greater than 100 to 1, with a width of 7.3 meters and a release height of 4.15 meters.

As indicated above, Figure C-3 illustrates a 20 km x 20 km gridded receptor field with uniform 500 meter spacing of receptors that are plotted as "●". Because a uniform grid sometimes places receptors on a roadway, those within 35 meters of a roadway were omitted. The basis for this is that these receptors are likely to fall on the roadway surface, versus a dwelling or workplace, and have high model-estimated concentrations, which could skew average concentration isopleths. Locations where receptors were removed are displayed as an "**x**" in Figure 3. After removal, 1533 of the original 1681 receptors remained.

The same meteorological data used by Sierra Research was used for the off-site modeling runs. The data were compiled by Environ from the nearby Lynwood (33.922°N, 118.211°W) and Los Angeles/USC (34.02°N, 118.28°W) stations. Upper air data for the same time period was obtained from the San Diego Miramar upper air station (32.833°N, 117.117°W). The model runs used one year of meteorological data from 2005.

Figure C-4 shows annual average diesel PM concentrations from the off-site emissions. Highest values occur near major freeways; the five highest concentrations at a receptor and their locations are provided in Table C-2.

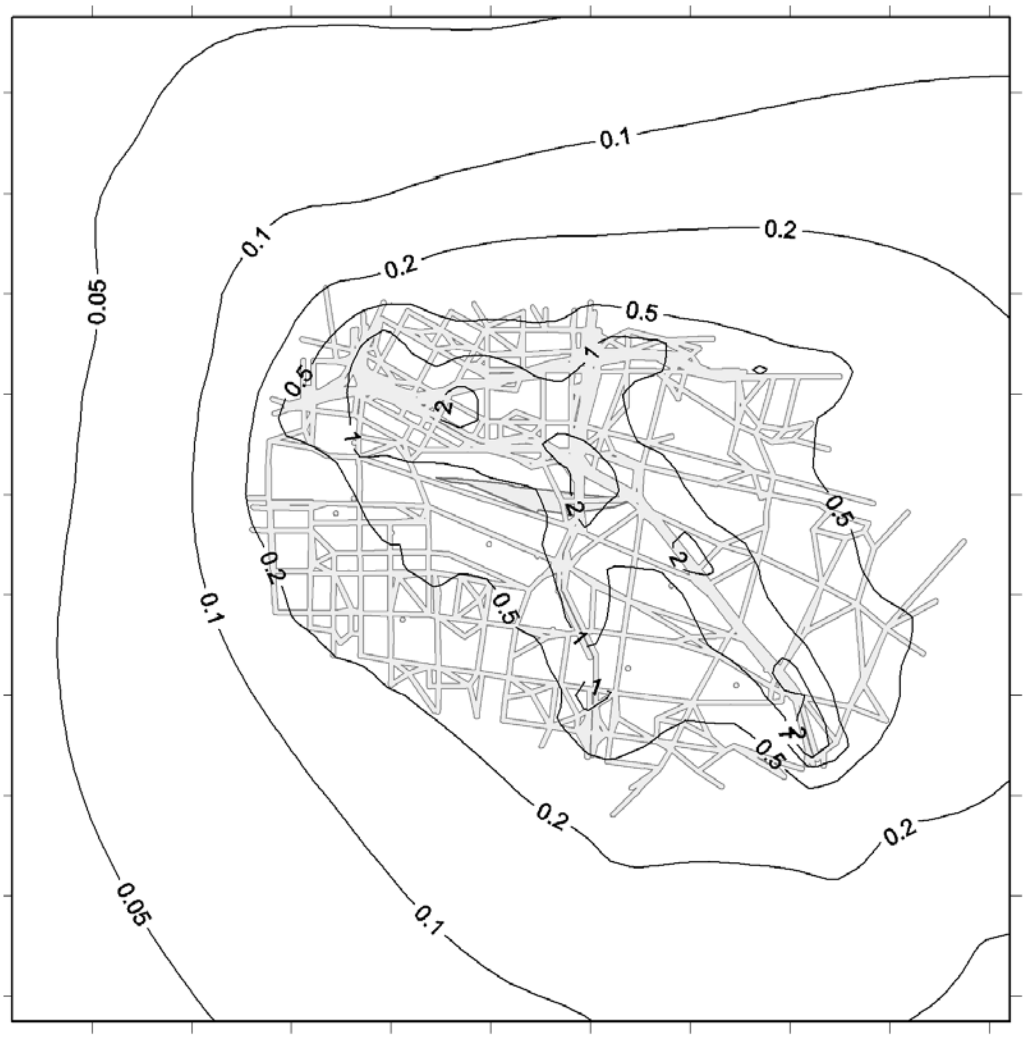

Figure C-4 The modeled annual average diesel PM concentrations ($\mu g/m^3$) from off-site diesel PM emissions.

Table C-2 Summary of maximum predicted annual concentrations ($\mu g/m^3$) and source contributions.

X	Y	Mobile	Stationary	Total (Off-site)
396400	3759000	3.380	0.0004	3.380
396400	3759500	3.339	0.0005	3.339
395900	3760500	2.944	0.0017	2.946
391400	3765000	2.747	0.0010	2.748
393900	3763000	2.617	0.0007	2.618

APPENDIX D

LOCOMOTIVE DIESEL PM EMISSION FACTORS

Locomotive Model Group	Cert Tier[a]	Emission Factors (g/hr) by Throttle Notch									
		Idle	DB[b]	1	2	3	4	5	6	7	8
Switchers (1)	Precntl	31.0	56.0	23.0	76.0	131.8	146.1	181.5	283.2	324.4	420.7
GP-3x (1)	Precntl	38.0	72.0	31.0	110.0	177.7	194.8	241.2	383.4	435.3	570.9
GP-4x (1)	Precntl	47.9	80.0	35.7	134.3	216.2	237.5	303.5	507.4	600.4	771.2
GP-50 (1)	Precntl	26.0	64.1	51.3	142.5	288.0	285.9	355.8	610.4	681.9	871.2
GP-60 (1)	Precntl	48.6	98.5	48.7	131.7	271.7	275.1	338.9	593.7	699.1	884.2
SD-7x (1)	Precntl	24.0	4.8	41.0	65.7	149.8	223.4	290.0	344.6	446.8	553.3
Dash-7 (1)	Precntl	65.0	180.5	108.2	121.2	322.6	302.9	307.7	268.4	275.2	341.2
Dash-9 (2)	Precntl	32.1	53.9	54.2	108.1	197.3	267.3	343.9	392.4	397.3	573.3
EMD 12-710G3 (3)	Precntl	27.5	54.5	34.0	112.5	186.6	216.8	270.1	379.3	445.4	591.0
GP-60 (4)	0	21.1	25.4	37.6	75.5	228.7	323.6	467.7	666.4	1058.5	1239.3
SD-7x (1)	0	14.8	15.1	36.8	61.1	220.1	349.0	407.1	796.5	958.1	1038.3
Dash-8 (1)	0	37.0	147.5	86.0	133.1	261.5	271.0	304.1	334.9	383.6	499.7
Dash-9 (5)	0	33.8	50.7	56.1	117.4	205.7	243.9	571.5	514.6	496.9	460.3
Dash-9 (4)	1	16.9	88.4	62.1	140.2	272.8	354.5	393.4	466.4	445.1	632.1
ES44/Dash-9 (4)	2	7.7	42.0	69.3	145.8	273.0	337.4	376.0	375.1	419.6	493.5

(1) Final locomotive emission factors (an update to the Roseville study emission factors Table B-1) received via email from Dan Donohue of ARB, May 9, 2006.
(2) “Diesel Fuel Effects on Locomotive Exhaust Emissions,” Southwest Research Institute, October 2000.
(3) “Locomotive Emission Standards”, Regulatory Support Document, U.S. EPA, Office of Mobile Sources, April 1997
(4) Confidential data from Southwest Research Institute (SwRI), 2005.
(5) Average of ARB and SwRI, 2005.
[a] Precntl: Precontrolled
[b] DB: Dynamic Braking

APPENDIX E

ESTIMATION OF DIESEL PM EMISSIONS FROM THE HHD TRUCKS TRAVELING BETWEEN RAILYAD AND MAJOR FREEWAYS

Introduction:

Diesel-fueled heavy-heavy-duty (HHD) trucks (weight >33,001 pounds) traveling between the intermodal railyards and major freeways generate certain amount of diesel PM emissions, which contribute the off-site diesel PM emissions. Using the same methodology in estimating the off-site HHD trucks diesel PM emissions, ARB staff estimated the diesel PM emissions of HHD trucks traveling between the railyard gates and the freeways. Estimate of the diesel PM emissions from HHD diesel trucks can be performed based on average speed on the local streets, distances traveled locally between the gates and the freeways, truck count at the railyard gates, and EMFAC model.

This analysis is conducted for the intermodal railyards whose diesel-fueled HHD trucks are a major contributor to the diesel PM emissions. At some railyards, HHD trucks also are idling or queuing outside of the railyards. These activities have been covered by the railyard on-site emission inventories and are not included in this analysis.

Methodology:

Estimating diesel PM emission from HHD diesel trucks can be performed by the following steps:

- Assume the average speed of trucks traveling on local streets between the railyard gates and the entrance/exit ramps of freeways.
- Select the most frequently traveled freeways for each railyard.
- Measure the distances from the gates to the ramps of selected freeways for each railyard using Google Earth Pro mapping tool.
- Use working draft of EMFAC model to obtain emission factor (gram per mile) associated with truck type, fuel use, and model year (as described in Appendix A: Methodology for Estimating Off-site Diesel PM Mobile Source Emissions).
- Calculate the associated diesel PM emissions.

Step 1: Assume average speed of truck travel from gate to freeway

The speeds of HHD trucks traveling on local streets range from 5 mph (start from the gate) to 35 mph (enter the freeway) depending on the time of travel, traffic conditions, etc. ARB staff assumes these speeds are averaged at about 20 mph.

Step 2: Select the most frequently traveled freeways for each railyard

This step is based on the assumption that the truck traffic heavily concentrated on one freeway than the others. According to the judges from the railyard operators, ARB staff chose the most frequently traveled freeways for each intermodal railyard, as described in Table E-1.

Table E-1 The most frequently traveled freeways by railyards and the distances from the railyard gates to the freeways

Railyards	Frequent Traveled Freeways	Roundtrip Distances from Gates to Freeways (miles)
UP Commerce	I-710	2.6
BNSF Hobart	I-710	2.6
BNSF Commerce/Eastern	I-5	2.1
UP LATC	I-5	0.7
UP Mira Loma	CA-60	2.2
BNSF Richmond	CA-580	1.74

Step 3: Estimate the distances from the gate to the most frequently traveled freeway

The distances of the local streets from the railyard gates to the entrance/exit ramps of the selected freeways are estimated by Google Earth Pro mapping tools. The results are presented in Table 1.

Step 4: Use the EMFAC model to obtain emission factor

The working draft of EMFAC, rather than EMFAC 2007 was used in the analysis as described in Appendix A. Emission factors based on vehicle type (in this case HHD diesel trucks), fuel type, and speed were developed by EMFAC. These are composite emission factors based on the model year distribution for each county and provided in units of grams of emissions per mile traveled. Finally, a matrix of emission factors by speed and vehicle type was assembled for each county for heavy heavy-duty diesel trucks. The following is an example of such a matrix (Table E-2).

Table E-2 Emission factor (grams per mile) of HHD diesel trucks

Speed (mph)	L.A. County	Contra Costa County
12	2.371	1.315
20	**1.277**	**1.176**
45	0.728	0.712
60	1.095	1.009

Step 5: Calculate the heavy heavy duty truck diesel PM emissions

The calculation of diesel PM emissions can be expressed by the following equation:

Total Emission (grams) = EF X (Volume X Distance Traveled)

EF represents diesel PM emission factors. The volume of trucks count at the railyard's gates was provided from the railroad operation data.

The emissions inventory developed by this methodology only included diesel PM emissions from running exhaust, the primary diesel source from on-road mobile emissions. Emissions from other modes such as idling, starts, and tire/break wear were excluded.

The results of the HHD trucks diesel PM emissions while traveling between each intermodal railyards and major freeways are presented in Table E-3.

Table E-3 Estimated diesel PM of HHD trucks travel from gate to freeway

Railyard	Route	At speed 20 mph** Distance Traveled		Truck trip/day	Diesel PM	
		1-way miles	RT miles		g/day***	tpy
BNSF Hobart	Gate to I-710*	1.3	2.6	3533	11,730	**4.72**
UP Mira Loma	Gate to CA-60*	1.1	2.2	321	1,618	**0.65**
UP Commerce	Gate to I-710*	1.3	2.6	1026	3,406	**1.37**
BNSF Commerce/Eastern	Gate to I-5*	1.05	2.1	557	1,494	**0.60**
UP LATC	Gate to I-5*	0.35	0.7	512	457	**0.18**
BNSF Richmond	Gate to I-580*	0.87	1.74	153	341	**0.13**
	Total					**7.65**

Note: * Assumed all trucks take this route

** Assumed all trucks' speeds are 20 mph from gate to freeway

*** HHD Emission Factors at 20 mph: 1.277 g/mi for LA County and 1.176 g/mi for Contra Costa County

APPENDIX F
SPATIAL ALLOCATIONS OF MAJOR DIESEL PM EMISSION SOURCES AT THE BNSF SHEILA MECHANICAL RAILYARD

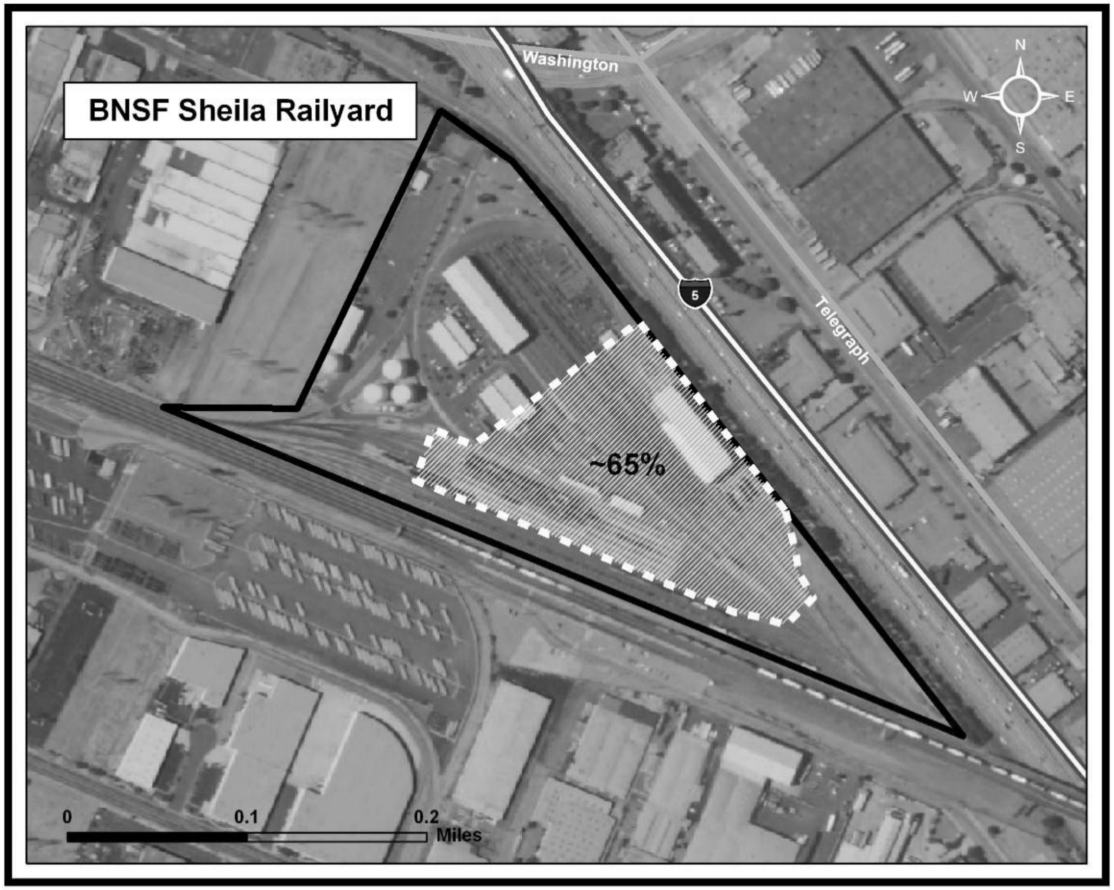

Figure F-1 The BNSF Sheila Mechanical Railyard shown with the shaded area accounting for about 60% of facility-wide diesel PM emissions.

Note: At the BNSF Sheila Railyard, the about 65% of the emissions occur in the central part of the yard. These emissions are generated largely by basic locomotive service activity and basic engine inspection activity which account for about 1.8 tons of diesel PM emissions in 2005.

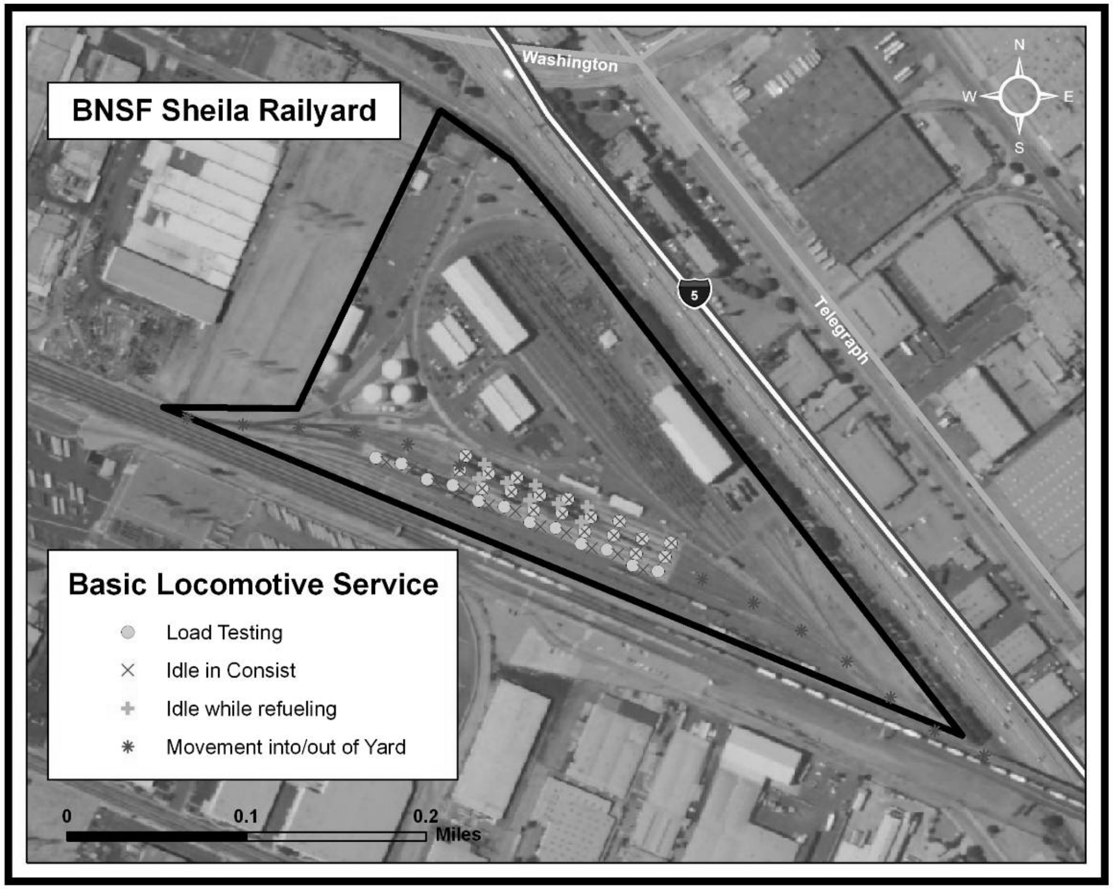

Figure F-2 Spatial allocation of locomotive service emissions at BNSF Sheila Mechanical Railyard.

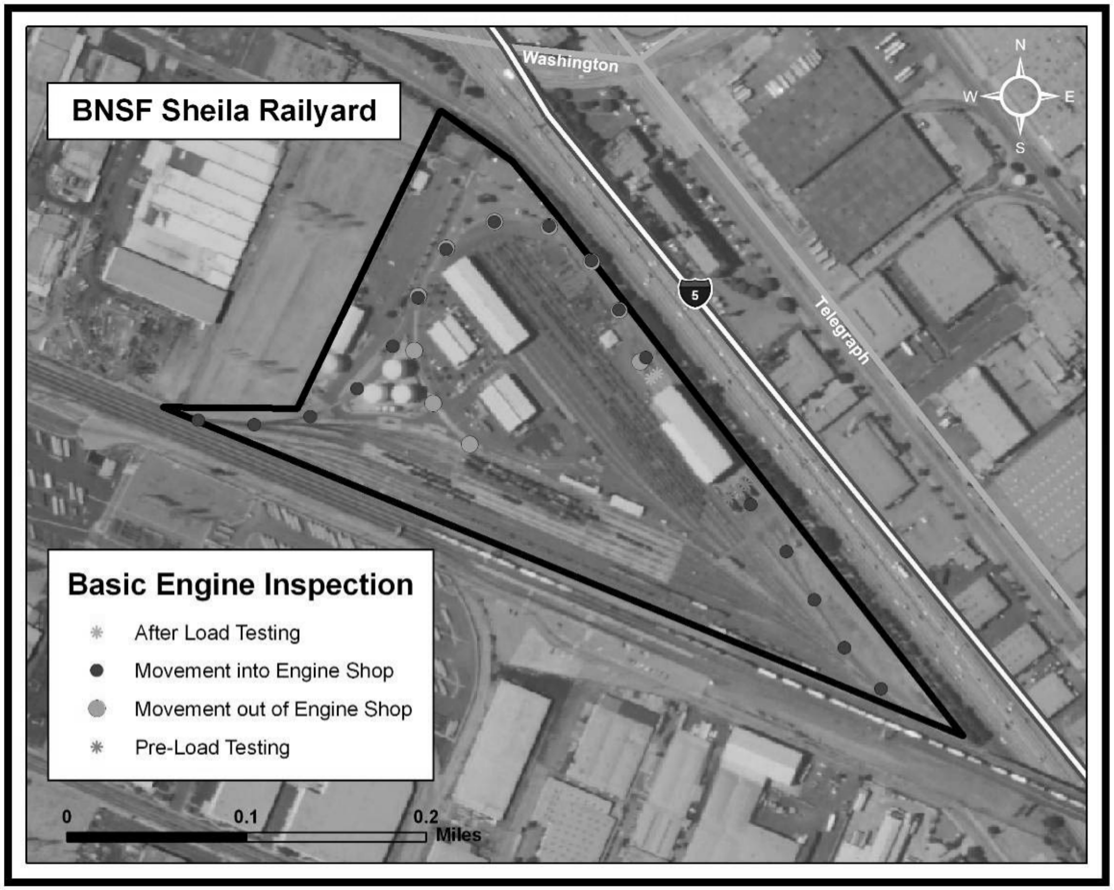

Figure F-3 Spatial allocation of locomotive inspection emissions at BNSF Sheila Mechanical Railyard.

APPENDIX G

AERMOD MODEL SENSITIVITY ANALYSIS OF METEOROLOGICAL DATA (ONE- VS. FIVE-YEAR DATA)

Figure G-1 AERMOD's Simulated Diesel PM Concentrations (due to On-site and Off-site Diesel PM Emissions) around UP Stockton Railyard Using One-year Meteorological Data..

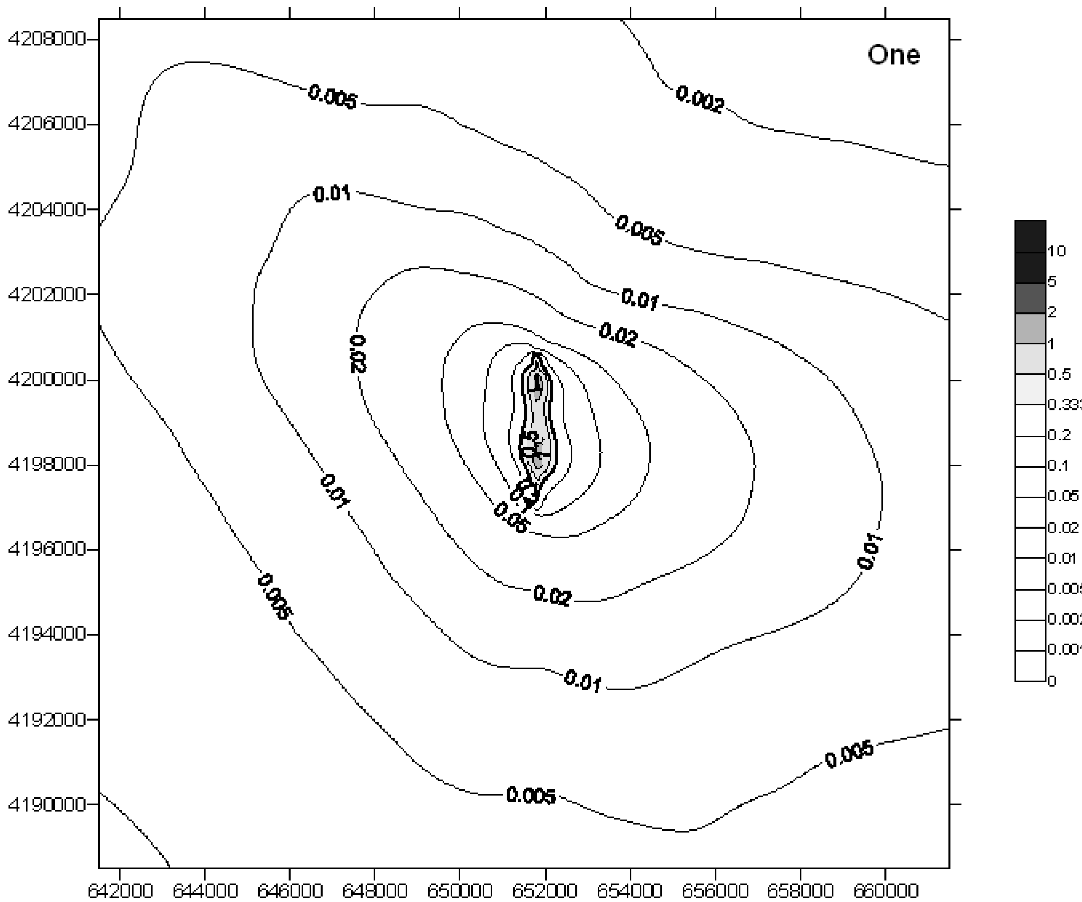

Figure G-2 AERMOD's Simulated Diesel PM Concentrations (due to On-site and Off-site Diesel PM Emissions) around UP Stockton Railyard Using Five-year Meteorological Data.